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STUDIES ON THE RATE OF DEVELOPMENT AND VIABILITY OF THE EGGS OF *ASCARIS LUMBRICOIDES* AND *TRICHURIS TRICHIURA* UNDER FIELD CONDITIONS*

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Most of the data on the rate of development and viability of the eggs of *Ascaris lumbricoides* and *Trichuris trichiura* have been obtained from the laboratory experiments in which the incubation and storage of the eggs were in aqueous media. Railliet (1893) found that at a favorable temperature Ascaris eggs contained motile embryos in 30 to 40 days. Davaine (1858) noted the formation of embryos in 30 days when Ascaris eggs were kept at a temperature of about 40° C. Likewise Leuckart (1876) found that in mid-summer the embryos are completely formed at the end of 40 days. More recently Wharton (1915) has reported that at summer temperatures in the Philippines Ascaris eggs develop completely in 15 days. From such data most workers conclude that in nature under the most favorable conditions of temperature and moisture the eggs of Ascaris take from 30 to 40 days to develop and those of Trichuris about twice as long. Likewise from the experiments of Davaine (1863), Morris (1911) and Epstein (1892) in which the eggs of Ascaris and Trichuris remained infective as long as five years in preserved feces it has been argued that eggs of these species probably remain viable and infective in nature a corresponding length of time. This opinion has been supported further by the results of experiments by Baillet (1866) and Cram (1924) who found Ascaris and Trichuris eggs to be very resistant to freezing temperatures. Ross (1916) reported that Ascaris eggs were still viable after having been exposed dry to the hot sun of India for as long a period as six weeks. Later workers on the other hand have found 98° C. lethal to dry Ascaris eggs. Ransom and Foster (1920) sum up the probable longevity of Ascaris eggs as follows; "Because of the great longevity of the eggs it is evident that the soil exposed to a continual pollution with feces of infested human beings or pigs may become in the course of

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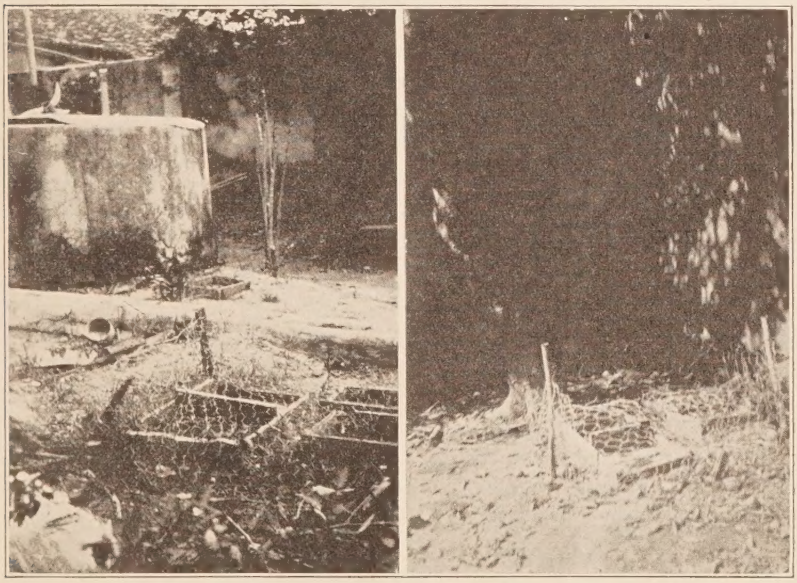
time very heavily ladened with living Ascaris eggs. It is also evident that places not exposed to fresh contamination may retain their infection for years." Whether or not these results of laboratory experiments can be used as a measure of what occurs to the eggs of Ascaris and Trichuris in nature is questionable. Further investigation is needed on the actual development and viability of the eggs of these two species under field conditions, especially in regions where the incidence among the population is high.

As far as the author is aware from a study of the literature no quantitative or qualitative data upon the development and viability of Ascaris or Trichuris ova under actual field conditions have been published. The reason for this lack of knowledge upon such an important question is that no adequate method of isolating ova from the soil was devised until the work of the Caldwells (MSS). Mhaskar (1924) by means of a centrifuging and flotation method was able to isolate ova from night soil trenches but his data record only the presence or absence of ova. He found Ascaris ova to develop in 11 weeks in night soil trenches but failed to find viable ova after 22 weeks. Other workers have been able to demonstrate the presence of Ascaris ova in spots known to be heavily polluted by means of a simple soil smear, but never in quantities sufficient to obtain a picture of development.

The general purpose of the experiments included in this paper was to ascertain the rate of development and viability of the eggs of *Ascaris lumbricoides* and *Trichuris trichiura* under actual field conditions in the region of Penonomé, Republic of Panama. To do this it was necessary to set up conditions as similar as possible to those encountered in nature. In as much as human excrement containing Ascaris and Trichuris eggs is found on all types of soil in both the sun and shade, it was essential to duplicate these conditions in the experimental cultures. To this end cultures were made on four types of soil, vis., sand, loam, clay and humus both in the sun and in the shade. To reproduce natural soil pollution, lumps of human feces containing large numbers of Ascaris and Trichuris eggs were placed on the different soils. The eggs were thus exposed to the elements and insect activities just as are those deposited in feces in ordinary soil pollution. To study the course of development eggs were isolated from the soil of the cultures at intervals in quantities sufficient to determine their rate of development.

From the rate of development of the ova under the different sets of conditions an analysis is attempted of some of the factors influencing their development and viability. From the temperature and humidity data gathered during the course of the experiments and their effect on the eggs it is believed that some application of the results can be made to other countries having a climate all or part of the year similar to that encountered during the experiments.

For culture use the different soils to a depth of about five inches were placed in wooden boxes 12 by 9 by 6 inches. These boxes were sunk into the ground in the shade and sun locations until the soil in them was on a level with the soil surrounding the box. Holes bored in the bottom of the boxes allowed drainage of rain through their soil. After the soils had been exposed to the rains for several days and had settled, their condition was believed to be quite similar to that in nature and ready for the "planting" of the feces containing the Ascaris and Trichuris eggs. This was done by merely dropping a 40 to 50 gram lump of feces upon the center of the soil in each box. The boxes were



Text Figure 1 Text Figure 2

Text figure 1. Soil cultures exposed to direct sunlight. The shaded cultures are beneath the tree in the right of the picture.

Text figure 2. Soil cultures in the shade.

then covered with a coarse chicken screening to keep out rodents and chickens (text figs. 1, 2).

To eliminate any possible variation in development due to types of feces in which the eggs were passed, material was obtained from two sources. Feces used in cultures 1 to 7, inclusive, were obtained from a boy of 8 years and were all of soft-formed consistency. They were egg-counted by the Stoll (1923) method and then put in an icebox to prevent development until a sufficient quantity had been secured to plant all seven cultures at once. The egg-count showed 55,000 Ascaris, 3,000 Trichuris, and 15,000 hookworm eggs present per gram of feces. After thorough mixing 40 grams were dropped on

each culture. This amount was about that passed by the boy in a normal stool and contained sufficient eggs for a number of isolations. Feces for the remaining cultures were from an adult, were of formed consistency and contained slightly fewer eggs per gram. The procedure was followed as above. On account of the lower egg count 50 grams were used in each culture.

To obtain a sufficient number of eggs for examination the procedure was as follows. Soil was obtained by scraping off the upper quarter inch of soil in different parts of the culture with a spatula. About two grams of soil were collected in this manner for each isolation. To separate the eggs from the soil a flotation technique essentially like that of the Caldwells (MSS) was used. This method consists of first freeing the eggs from the soil particles to which they adhere and then of floating them free with a solution of sufficient specific gravity to buoy up the eggs but not the soil particles. A portion of the surface film of the isolation was then transferred to a 2 by 3 slide by means of looping off with the open end of a small test tube. This preparation was then covered with a coverslip. By means of a mechanical stage the whole slide can be examined without repeating any portion of it, the focus being kept upon the lower side of the coverslip as the eggs are buoyed up to it. In practice every egg that comes into the field is examined and classified until the required number is obtained; this eliminated any error that might arise due to unconscious selection.

Five stages of development were chosen for classification, following in general the nomenclature and divisions of Looss (1911). They are as follows; one cell, early morula (2-16 cells), late morula (16 cells to completed morula), tadpole, motile embryo, and degenerate (eggs showing granulation, vaculations, or clearing). From the first isolations 500 to 700 eggs were examined and classified according to developmental stage. Each 100 eggs examined was listed separately in order of examination. It was found that the picture of the developmental stages of 200 eggs was very similar to that of 500. Hence to save time, as long as accuracy was not sacrificed, only 200 eggs were examined from each isolation. When the first two counts of 100 eggs each did not check closely an additional 100 were examined. This proved to be an important factor in saving time as each egg was examined with the high power (10x eyepiece and 4 mm objective).

Before detailing the culture results, two questions bearing on the accuracy of the sampling and isolation method must be considered. First, is the sample of soil taken at any one time, a fair sample of the whole culture? It was noted that the feces, notably those of the soft formed type spread out over the soil very evenly due to the action of insects and rain. Isolations on the same day from different parts of the culture varied but little and as each isolation included soil from all parts of the culture it is reasonable to assume that each soil sample

gave a fair picture of the whole culture at that time. Formed stools disappeared more unevenly, often leaving small solid particles. The pictures of ova development given by these hard pieces of feces were very different from those of the surrounding mixture of soil and feces (Table IId and IV). In sampling this type of culture these hard particles were included to give a picture of the total development in the culture. The second question is whether in the isolation of the eggs from the soil all stage float to the surface of the isolation mixture in the same ratio in which they are actually present. This point has

TABLE I—*Temperature and Rainfall Record During Course of Experiments*

	Shade, Maximum	Shade, and Sun, Minimum	Sun, Maximum	Rain, Inches		Shade, Maximum	Shade, and Sun, Minimum	Sun, Maximum	Rain, Inches
July 9	91.0	72.0	....	0.65	Aug. 8	78.5	73.0	79.0	0.55
10	85.0	73.0	90.0	....	9	96.0	69.0	99.0	....
11	89.5	73.0	93.5	0.20	10	93.0	74.0	102.0	....
12	94.0	74.0	101.0	....	11	91.0	74.0	98.0	0.30
13	95.0	76.0	102.5	....	12	92.5	73.5	99.0	....
14	92.0	76.5	99.5	....	13	87.5	71.0	92.0	1.30
15	83.0	74.0	93.0	0.90	14	90.0	72.5	102.0	0.55
16	87.5	71.0	91.5	....	15	89.5	73.5	97.5	....
17	84.0	72.5	88.5	....	16	83.5	73.5	88.0	0.25
18	94.0	71.0	99.5	0.40	17	88.5	73.0	95.0	0.30
19	82.5	74.5	99.0	....	18	94.0	72.0	100.5	....
20	90.0	72.0	95.5	....	19	89.5	73.0	95.0	....
21	86.0	74.0	95.0	Rain	20	90.0	73.5	95.0	....
22	88.0	71.5	98.0	Rain	21	92.0	72.0	102.0	....
23	76.5	73.0	76.0	0.25	22	91.0	72.0	97.0	0.50
24	91.0	71.0	99.0	....	23	86.0	74.0	96.0	0.10
25	87.5	73.0	95.0	0.20	24	87.0	72.5	95.0	0.30
26	89.5	74.0	98.5	....	25	94.0	69.5	97.5	0.10
27	95.0	73.5	101.0	....	26	95.5	72.0	100.5	0.10
28	91.0	73.0	99.5	1.60	27	90.5	72.0	97.0	....
29	83.0	72.0	84.0	0.30	28	90.5	73.0	99.5	0.20
30	94.5	71.5	100.0	....	29	82.0	72.0	84.0	0.15
31	88.5	73.0	94.5	....	30	91.0	71.0	99.5	0.20
Aug. 1	87.5	73.0	94.0	0.95	31	90.5	74.0	94.5	....
2	89.0	71.0	97.0	....	Sept. 1	91.5	72.0	99.5	0.20
3	91.5	72.0	99.0	....	2	91.0	74.5	92.5	....
4	91.5	74.0	96.5	....	3	86.0	71.0	....	1.55
5	91.5	75.0	98.0	....	4	90.5	68.0	....	0.40
6	97.0	72.0	102.5	....	5	87.0	71.0	....	0.65
7	92.0	73.0	101.0	0.25	6	....	....	....	0.30
Average						89.4	72.6	95.8	
Total									13.7

been checked by a comparison of the percentages of eggs in the different stages obtained by the flotation method and a dilution count of the same material. The same results were obtained by both methods by the Caldwells and myself.

TEMPERATURE AND HUMIDITY

Since temperature and moisture are determining factors in the development of nematode eggs, the records of temperature and rainfall will be given before going on to the discussion of the results of the experiments.

During the course of the experiments temperature readings were made twice daily (Table I) at 7 a. m. and 7 p. m., with sets of Tycos maximum and minimum thermometers. The thermometers were placed

directly over the cultures in the sun and shade. For the 59 days between July 9 and September 6, inclusive, the period for which the cultures are given, the mean maximum daily temperature in the shade was 89.4° F. ranging between 76.5° F. on July 23 and 97° F. on August 6. The mean maximum daily temperature in the sun was 95.8° F., ranging from 76.0° F. on July 23 to 102.5° F. on July 13 and August 6. As the minimum temperature always occurred at night and was not influenced by the sun or shade only one set of minimum temperature data is given although they were taken in both locations. The mean minimum temperature was 72.6° F. ranging from 68° F. on September 4 to 76° F. on July 13. With these rather uniform temperatures there was high humidity, showers occurring almost daily and with frequent heavy rains. Rainfall was measured daily (Table I) as it fell into a 500 cc. graduate cylinder. By this method as little as $\frac{1}{20}$ of an inch was registered. When less than this amount fell it is recorded as rain but no amount given. A total of 13.7 inches were recorded during the 59 days of the experiments.

The results of the examinations of the cultures are shown in tables II, III, IV and V. An isolation from the sand culture in the shade ten days after planting (Table IIa) showed that 98.6% of the ova were degenerate. Subsequent isolations at 15, 21, and 37 days revealed that all the eggs had degenerated by the 21st day and not one was found at any time in the motile embryo stage. This finding was so striking that a check culture was placed along side of the original sand culture (Table IV). Examinations of the check culture gave results practically identical to those of the original culture.

The eggs planted in the sandy soil in the shade, however, showed a gradual development to the motile embryo stage. A glance at table IIa shows that 33.5% of the eggs contained motile embryos after 15 days and 90.8% after 35 days. Nineteen days later the percentage of eggs containing motile embryos had dropped to 69 with 31 classed as degenerate; no ova were found at that date in the early stages of development.

The loam soil cultures in the shade and sun were quite similar. Table IIb shows that the culture in the shade was behind the sun culture in the production of eggs containing motile embryos for the first 15 days; 19.5% of the eggs in the shaded culture were in this stage as compared with 46% for the sun culture. This ratio was reversed by the 21st day, for an isolation on this day showed that 89% of the eggs in the shade culture contained motile embryos and only 54% in the sun culture. It was not until the 37th day that the sun culture showed a percentage of eggs containing motile embryos that equaled that of the shade culture at 21 days. The number of degenerate eggs in the shade and sun cultures for the first 21 days was practically the same.

TABLE II.—*Chronological Development of Ascaris Eggs in Soil Cultures in Both Shade and Sun*

Shade									Sun								
II a. Sand Soil Cultures																	
Isolation Date	Days in Soil	Culture No.	No. Ova Examined	One Cell	Early Morula	Late Morula	Tadpole	Motile	Degenerated	Isolation Date	Days in Soil	Culture No.	No Ova Examined	One Cell	Early Morula	Late Morula	Tadpole	Motile	Degenerated
7/19/26	10	1	200	6.5	32.5	45.5	0.5	0	15.0	7/20/26	10	5	700	0	1.4	0	0	0	98.6
7/24/26	15	1	700	6.9	9.1	16.1	24.0	33.5	11.4	7/25/26	15	5	500	0	0.2	0.2	0.2	0	99.4
7/30/26	21	1	600	2.1	2.3	3.5	2.4	76.0	13.7	8/31/26	21	5	500	0	0	0	0	0	100
8/14/26	35	1	600	0.2	0.8	1.0	0	90.8	7.3	8/16/26	37	5	100	0	0	0	0	0	100
8/24/26	45	1	200	0	0	0	0	73.0	27.0										
9/ 2/26	54	1	200	0	0	0	0	69.0	31.0										
II b. Loam Soil Cultures																	
7/19/26	10	2	200	3.0	26.5	66.0	3.0	0	1.5	7/20/26	10	6	200	2.0	29.0	66.0	0	0	3.0
7/24/26	15	2	200	8.5	8.0	37.0	23.5	19.5	3.5	7/25/26	15	6	300	2.0	8.7	22.0	19.3	46.0	2.0
7/30/26	21	2	200	0.6	1.0	3.3	2.3	89.3	3.5	7/31/26	21	6	300	0.3	6.0	24.7	11.0	54.0	4.0
										8/16/26	37	6	100	0	0	2.0	0	87.0	11.0
II c. Clay Soil Cultures																	
7/19/26	10	3	200	0.5	29.0	64.5	3.0	0	3.0	7/20/26	10	7	200	2.0	25.5	66.5	0	0	6.0
7/24/26	15	3	500	0.4	2.4	26.0	21.0	49.8	0.4	7/25/26	15	7	300	3.0	2.0	12.5	12.3	65	4.6
7/30/26	21	3	200	0	0.5	8.0	4.5	85.0	2.0	7/31/26	21	7	300	1.5	2.6	7.0	5.3	71	12.6
										8/16/26	37	7	300	0	0	0	0	93	7.0
II d. Humus Soil Cultures										Shade									
7/19/26	10	4	200	65.5	25.0	9.0	0	0	0.5	8/ 6/26	10	9	200	82.5	15.5	1.0	0	0	1.0
7/24/26	15	4	500	29.2	34.6	24.0	5.4	5.0	1.8	8/11/26	15	9	300	29.0	23.0	37.6	6.0	4.0	0.3
7/30/26	21	4	300	18.0	12.5	28.3	12.0	27.6	1.6	8/18/26*	22	9	200	64.5	18.5	8.5	1.0	6.0	1.5
8/14/26	35	4	200	6.5	13.5	8.5	4.5	64.5	2.5										
9/ 6/26	56	4	100	1.0	3.0	6.0	1.0	83.0	6.0										

* Material for this isolation taken from a lump of moist feces in the center of the culture.

TABLE III.—*Chronological Development of Trichuris Eggs in Sandy Soil in Shade Culture*

Sandy Soil Culture: Shade									
Isolation Date	Days in Soil	Culture No.	No. Ova Examined	One Cell	Early Morula	Late Morula	Tadpole	Motile	Degenerated
7/19/26	10	1	44	75.0	25.0	0	0	0	0
7/30/26	21	1	67	22.5	3.0	7.5	18.0	33.0	16.0
8/14/26	35	1	100	4.0	5.0	6.0	3.0	74.0	8.0

TABLE IV.—*Chronological Development in Check Culture of Ascaris Eggs in Sandy Soil in Sun Culture*

Sandy Soil Culture: Sun									
Isolation Date	Days in Soil	Culture No.	No. Ova Examined	One Cell	Early Morula	Late Morula	Tadpole	Motile	Degenerated
8/ 6/26	10	8	300	0	0	3.0	0	0	97.0
8/ 6/26	10*	8	300	0.3	15.6	44.3	0	0	40.0
8/11/26	15	8	400	0.25	0	0.5	0	0	99.25
8/17/26	21†	8	100	0	0	0	0	0	100.0

* Material for this isolation consisted of a small piece of hardened caked feces.

† Isolation made from a small pellet of hardened feces contained eggs in all stages of development.

TABLE V.—*Percentages of Eggs Containing Motile Embryos at Different Time Intervals in Sand, Loam, Clay, and Humus Soils in the Sun and in the Shade*

TABLE VI.—*Comparison of Air and Soil Temperatures in Sun and Shade*

Shade		Sun	
Air Temperature	Soil Temperature	Air Temperature	Soil Temperature
88 F.	Sand 82 F.	95 F.	Sand 123 F.
88 F.	Loam 81 F.	95 F.	Loam 107 F.
88 F.	Clay 79.5 F.	95 F.	Clay 103 F.
88 F.	Humus 80.5 F.		

The history of the clay soil cultures (Table IIc) is comparable to the loam soil cultures except that a much higher percentage of eggs attained the motile embryo stage in the first 15 days, 49.8% in the shade and 65.6% in the sun. This relation was reversed in the next six days, the percentages in shade and sun being 85 and 71 respectively. At 37 days the sun cultures showed 93% of the ova with motile embryos, the remaining 7% being degenerate. The percentage of degenerate ova in the sun culture was five times that of the shade culture.

The humus cultures were placed in the shade only as it is usually under the shade of trees that this type of soil is found. These cultures show a steady but very slow development of the ova. Table IId shows the gradual increase in the number of eggs containing motile embryos from the 15th day when 5% were found to be in this stage until the 56th day when the percentage in this stage had risen to 83, with about 11% of the eggs still in the early stages of development and 6% degenerate.

Data in sufficient quantity to be significant upon the development of Trichuris eggs were obtained only in the sand cultures in the sun and shade. In the sun culture degeneration of the eggs took place before any contained motile embryos. In the shade culture, Table III, 33% of the Trichuris eggs contained motile embryos after 21 days while at the end of 35 days 74% of the eggs were in this stage.

DISCUSSION OF RESULTS

The development of Ascaris eggs to the motile embryo stage in 15 days was quite unexpected. The fact that some cultures contained 65% of the eggs in this stage 15 days after planting suggests that a considerable number attained this stage between the time of the first isolation at 10 days and the second isolation five days later. This rapidity of development is comparable to that found on the hut floors in the same region (Brown, 1927) and equals that in aqueous cultures incubated at 30°C. in the laboratory, conditions which are considered to be the optimum. Likewise the development of Trichuris eggs to the motile stage in 21 days is much more rapid than anticipated. This rapid development is also emphasized by the fact that during the night the temperature fell to a point at which these helminths eggs have been found to develop only with exceeding slowness. Trichuris eggs brought back from Panama in 2% formalin when incubated at 30°C. in aqueous cultures all failed to develop and after several months all degenerated while the Ascaris eggs from the same culture all developed normally to infectivity. This and the fact that the Trichuris eggs in the sandy soil culture in the sun showed signs of degeneration sooner than did the Ascaris eggs leads to the conclusion that they are not as resistant as Ascaris eggs.

The degeneration of 100% of the eggs in the sand culture in the sun in such a comparatively short time is of great interest since it is the general opinion that Ascaris and Trichuris eggs are very resistant and remain viable for a considerable period of time. Davaine (1863) and others having kept the motile embryos of *A. lumbricoides and T. trichiura* alive for five years and Ransom and Foster (1920) state that places not exposed to fresh contamination may nevertheless retain their infection for years. That infective Ascaris ova may be similar to the hookworm larvae in not remaining viable as long in the soil under field conditions as when stored in different media in the laboratory is also indicated by work of Mhaskar (1924). He failed to find viable Ascaris or Trichuris eggs in soil from night soil trenches after 22 weeks. All the eggs found at this time were degenerate although in examinations some weeks before he found embryonated eggs of both the worms. Table IIa lends further support to the idea that the longevity of the ova may not be as great as is generally supposed. In the sand culture in the sun they were all degenerate in 21 days while in the sand shade culture there was a marked decrease in the number containing motile embryos as the time progressed. At 35 days this culture reached its maximum with 90.8% of its eggs in the embryonated stage while at 45 and 54 days respectively only 73% and 69% were in this stage. This indicated a decided death rate of embryos over such a short period as 19 days even under conditions that are very favorable for their development. Further work is being carried on to determine the longevity of the eggs under field conditions.

To explain the rapid death and degeneration of the eggs in the sand cultures temperature and desiccation were at once considered. Table VI gives the air temperatures and soil temperatures taken at the same time. The soil temperatures were taken with the bulb of the thermometer one quarter inch below the surface. It will be noted that the sandy soil temperature in the sun was far above those of the other soil cultures in the sun. On several days the air temperature rose to 102° F. and above and although soil temperatures were not taken at these times the sand in the sun must have been considerably above 123° F., its temperature on several occasions when the air temperature was only 95° F. However, without even assuming the temperature of the sand rose above 123° F., several sources show that this temperature is lethal to Ascaris eggs. Ogata, (1925) found that Ascaris eggs lose their power to develop after exposed to 122° F. for 45 minutes, and Ransom (1920) found that the eggs of *A. suum* when exposed to 98° F. until extremely dry did not continue to develop when exposed to lower temperatures. Although rain fell practically every day, usually in the morning, it was noted that by the middle of the afternoon the sand culture was in most cases already quite dry while the cultures of

the other soils were still moist. No doubt the slower evaporation of moisture from those cultures reduced their temperatures more uniformly and over a longer period of time than the sand cultures which quickly lost their moisture, and with it its protective cooling action. That this destruction of Ascaris eggs is not a matter of culture experiments alone but also actually occurs in the field was demonstrated by an isolation from sandy soil collected from beneath the eves of a hut in El Coco, Panama. The soil was in the direct sunlight and showed signs of recent pollution. On questioning the children living there it was found that pollution of this spot had been practiced for some years. Judging from the literature one would have expected to find an enormous number of infective Ascaris eggs present as the children were heavily infested, the two children passing a total of over 25,000,000 eggs per day. Yet of the hundreds examined from this spot not a single viable egg past the morula stage was found although countless degenerate eggs were seen. This indicates a rapid death of the ova after deposition, for undoubtedly those found in the early stages of development were from the stools deposited so recently as to still be viable and not yet wholly mixed with the soil.

Such marked differences in the rate of development of the Ascaris eggs in the different types of soil indicate the presence of sets of conditions which vary greatly in their favorableness toward their development. Sun cultures in which the development was very rapid for the first 15 days stood practically still for the next six days while similar cultures in the shade in which the development had been much slower the first 15 days far outstripped the sun cultures in the succeeding 6 days, producing a percentage of motile embryos that it took the sun cultures 22 additional days to equal. Such a retarded rate of development of the eggs as occurred in the humus cultures (Table IId) indicates a less favorable environment than was present in the other soils. The humus soil cultures took twice as long to produce as many eggs containing motile embryos as did the other soils. This retardation of development cannot be ascribed to temperature as a glance at Table VI shows the temperature of this culture to fall directly between the loam and clay soil cultures, in which the egg development was very rapid. It was noted, however, that the humus cultures retained the moisture and that the usual leveling and mixing action of the insects was very much retarded leaving the feces in large soggy masses while on the other soils 48 hours after planting the feces were thoroughly mixed with the soil. It is quite likely that the oxygen supply, shown by Hallez (1885) to be necessary for development, of the eggs was thus greatly reduced and that this accounts for their slow development. In buried feces the development was retarded even more than in the humus cultures. Further, a sample from the center of a large fecal

mass in the humus culture showed the stages of development of the eggs to be behind that of those from the outside portions of the lump.

The consistency of the stool used in culture experiments of this type had a very definite effect upon results. The soft formed and mushy types are quickly and evenly mixed with the soil. The formed stools are more slowly leveled by insects and rain and usually small pieces of hardened feces remain. It will be noted (Tables IIa and IV) that all isolations from the sand cultures in the sun showed 100% degeneration of eggs in 21 days where the feces and soil were well mixed but a glance at the note at the bottom of table IV shows that from the hardened particles of feces in sand cultures in the sun eggs in all stages of development were obtained in the isolation on the 10th and 21st days of the culture. This was a formed stool culture. What importance these small pellets have in the spread of Ascaris is not known.

That there is some passive migration of helminth eggs in the soil is illustrated by the fact that from the older cultures it was more difficult to obtain Ascaris eggs in the abundance found in the first isolations, although the total ova left in the culture was not appreciably diminished. Whether this migration, presumably due to the washing of rains, is lateral or vertical and whether it varies with soils has not been quantitatively worked out. From a study of the cultures in these experiments it seems likely that the migration of eggs through soils varies considerably. This may be an important item in the epidemiology of helminth infections obtained orally through the agent of eggs.

The development of Ascaris and Trichuris eggs in the United States

To what extent the findings on the rate of egg development and viability in the different types of soils in Panama can be applied to the United States depends to a large extent on the temperature and rain fall of the different states. Table VII gives a comparison of temperatures and rain fall of several of the southern states (average for the past 50 years) with those encountered in Penome, Panama, during the course of the culture experiments. Although there are no data on the actual time duration of each temperature it is quite safe to assume that the average of the maximum and minimum temperatures gives a fair index to the temperature of the whole days. Granting this it appears that the mean temperature at Jacksonville, Florida, Baltimore, Maryland, and New Orleans, Louisiana, for June, July, August and September corresponds very closely to that encountered during the experiments in Panama, and that the rainfall during this time was also quite similar in amount to that in Panama. The summer temperature and rainfall data taken for Alabama as a whole also compares favorably with that of Penonome. It follows quite naturally that since Florida, Louisiana, and Alabama have the four types of soils used in this study

it is not at all unreasonable that Ascaris ova develop to the embryonated stage in 15 days in these states. No doubt a large part of the southern U. S. affords just such favorable temperature and rainfall conditions for the development of the eggs of Ascaris and Trichuris and that the statement of 30 to 40 days necessary for the development of Ascaris and several to six months for the development of Trichuris are both inaccurate. Of course during the winter months with lowered temperatures the development of ova would be much retarded. This is in some respects comparable to the interesting question of what happens to eggs during the four consecutive months in Panama during which no rain falls and temperatures are above those recorded in this

TABLE VII.—*Comparison of Temperature and Rainfall Data from the Southern United States with that Recorded for Penonomé, Panama*

	June				July			
	Average Maximum, F.	Average Minimum, F.	Max. and Min. Average	Inches Rain	Average Maximum, F.	Average Minimum, F.	Max. and Min. Average	Inches Rain
Panama	89.4	72.6	81.0	6.25	89.4	72.6	81.0	6.25
Baltimore	81.4	64.0	72.7	3.84	85.4	69.1	77.4	4.82
Jacksonville	87.9	71.8	79.9	5.53	90.2	74.0	82.1	6.20
New Orleans	89.3*	74.4*	81.8*	6.16*	90.5*	75.7*	83.1*	6.47*
Alabama	89.2*	66.3*	78.3	4.93	90.1*	68.2*	81.1	6.13

	August				September			
	Average Maximum, F.	Average Minimum, F.	Max. and Min. Average	Inches Rain	Average Maximum, F.	Average Minimum, F.	Max. and Min. Average	Inches Rain
Panama	89.4	72.6	81.0	6.25	89.4	72.6	81.0	6.25
Baltimore	83.6	67.4	75.5	4.21	76.7	60.3	68.5	3.85
Jacksonville	89.6	73.7	81.7	6.21	85.5	71.1	78.3	8.03
New Orleans	90.5*	76.8*	83.6*	5.61*	89.4*	75.7*	82.6*	4.81*
Alabama	90.0*	71.2*	79.6	6.90	89.5*	69.3*	75.4	4.93

* 1926 figures, all other figures are averages of temperature data for past 50 years.

paper. It would be very desirable to sample polluted areas before and after this period. It is obvious, however, from the isolation at house 11, El Coco, mentioned above that in sandy soil exposed to the sun the ova are not very likely to retain their viability over this period.

Caldwell and Caldwell (1926) cite the findings of Kerr and Rickard in Tennessee where the incidence of human Ascaris is high in the mountainous district and absent in the western plateau region. They conclude; "Economic, social, and sanitary conditions in the rural districts of these areas are similar. It would seem, therefore, that in the sandy costal plain there must be present other factors which are unfavorable for the development of human Ascaris. One of these factors may be the nature of the top soil." From the results of the experiments in Panama it seems quite probable that the type of soil may in part account for such distribution of Ascaris and Trichuris.

SUMMARY

1. Cultures made by depositing human feces containing Ascaris eggs upon sand, loam, clay and humus soils in the sun and the shade at Penonome, Panama contained eggs with motile embryos within 15 days.

2. Cultures on sand in the sun did not produce any embryonated eggs and in 21 days all the ova had degenerated.

3. In the sandy soil culture in the shade 35 days after planting 90.8% of the eggs contained motile embryos; 19 days later 69.0% of the eggs were in this stage, the rest being degenerate.

4. In clay soil cultures after 21 days, 85% of the eggs in the shaded culture and 71% of the eggs in the sun culture were in the motile embryo stage.

5. In loam soil cultures at 21 days, 89.3% of the eggs in the shaded culture and 54% of the eggs in the sun culture were in the motile embryo stage.

6. Development of Ascaris eggs in humus soil cultures was at least 20 days behind that in sand, clay and loam soils.

7. In sand soil cultures in the shade 33% of the Trichuris eggs developed to motile embryo stage by the 21st day of the culture and 74% by the 35th day.

8. No Trichuris eggs developed as far as the motile embryo stage in the sand culture in the direct sunlight.

9. Results indicate that the type of soil is an important factor in rate of development and viability of Ascaris and Trichuris eggs.

10. Temperature and rainfall date from the southern United States are very similar to those in Panama during the experiments and indicate that the development of Ascaris and Trichuris ova in these states may be more rapid than generally supposed. Likewise longevity of the eggs at least in sandy soil may be much shorter than is usually accepted.

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NOTES ON THE CARYOPHYLLAEIDAE OF NORTH AMERICA

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This group of Cestodaria has been given considerable attention during the past few years by several European writers as Nybelin (1922), Woodland (1923, 1924, 1926), Fuhrmann and Baer (1925) and others. Among monographs on the parasites of North American fish, Cooper (1918) dealt with the Pseudophyllidea, omitting, however, the family Caryophyllaeidae. Since 1893 only four brief papers have appeared on the Carophyllaeidae of North America. Three of these added new species to existing genera and one created a new genus to hold the form described. The present paper is a preliminary report on the species found on this continent together with a description of several new species and a consideration of the genera of the family Caryophyllaeidae. The completed paper will be published later.

About 400 fish of the family Catostomidae, taken principally from the Rock and Mississippi rivers, were examined. A general account and summary of the collections has appeared (Essex and Hunter 1926). Many of the fish were examined in the field and during the fall and spring fish were shipped from the Rock River, thus enabling examinations to be made throughout the year. In the summer of 1926, the U. S. Biological Station at Fairport, Iowa, supplied the writer with material and laboratory facilities. The parasites were always studied alive and later after being fixed in either Bouin's or mercuric chloride (saturated aqueous solution). The writer wishes to express his sincere appreciation to Dr. Henry B. Ward, for his interest in, and criticism of, the work which has resulted in this paper.

The original material of Linton's *"Monobothrium" terebrans* and *"M." hexacotyle* as well as Lamont's type specimen of *"Caryophyllaeus" laruei* were obtained for comparison. Cooper's original specimens of *Glaridacris catostomi* were also available for study. It was possible therefore to make a careful examination of these four species. Each was found to be valid and on the basis of their anatomy were placed as follows:

Caryophyllaeus terebrans (Linton 1893)
Glaridacris hexacotyle (Linton 1897)
Glaridacris catostomi Cooper 1920
Glaridacris laruei (Lamont 1921)

It should be noted at this point that Cooper (1920) apparently confused *G. catostomi* with the form designated as *"C." laruei* by Miss Lamont in the following year. This is apparent for the figures of the

scolex of "*C.*" *laruei* appear in Cooper's paper and are described as belonging to the larva of *G. catostomi*. The larvae of *G. catostomi* and *G. laruei* are readily distinguishable as the former possesses a structureless scolex, wrinkled cuticula (about 25 μ in thickness), and a prominent genital atrium, all of which are the reverse of conditions found in *G. laruei* which has a definite scolex with 6 loculi and a terminal disc, thin cuticula, and no common genital atrium.

A study of the material collected by the writer shows the presence of three new genera and four new species. These are designated as follows:

Monobothrium ingens, n. sp.
Biacetabulum infrequens, n. g., n. sp.
Hypocaryophyllaeus paratarius, n. g., n. sp.
Capingens singularis, n. g., n. sp.

These will be discussed in detail in the pages which follow.

Through a study of the genera of the Cestodaria and an examination of the basis of classification advocated by Nybelin (1922) and Woodland (1923, 1926) it is apparent that there are three groups of related genera, the Caryophyllaeus group, the Lytocestus group, and the Wenyonia group. These three groups constitute the basis for subfamilies as the members of each group are more closely allied to each other than to any in the other groups. The same type of generic and specific characters have been used throughout. A summary of the revised classification follows though the detailed discussion will appear subsequently.

FAMILY CARYOPHYLLAEIDAE LEUCKART 1878

Family diagnosis: Pseudophyllideans with or without organs of adhesion on the scolex. Ovary and genital openings present, singly, lying on the ventral body surface. Testes exclusively confined to the medullary parenchyma; vas deferens anterior to cirrus sac, which is supplied with relatively thick, specialized muscles. Oviduct arises from an oöcapt taking its origin from ovarian commissure. Utero-vaginal duct without sphincter. Nerves present as two main longitudinal strands.

SUBFAMILY CARYOPHYLLAEINAE (NYBELIN 1922), char. emend.

Subfamily diagnosis: Caryophyllaeidae with sexual apertures and ovary within last quarter of body length. Longitudinal muscles usually of two layers, the inner always surrounding the vitellaria which are medullary and typically annularly arranged. Uterine glands present.

Type genus: Caryophyllaeus Müller 1787.

GENUS CARYOPHYLLAEUS MÜLLER 1787

Generic diagnosis: Caryophyllaeinae with anterior extremity broadened, folded or "curled," not specialized into loculi, bothria or

suckers. Cirrus opens on ventral surface or into shallow, non-eversible genital atrium. Ovary "H" shaped and entirely medullary. Uterine coils never anterior to cirrus sac, with maximum length one-third that of testicular field, usually less. No external seminal vesicle; post-ovarian vitellaria present. Parasitic in digestive tract of Cyprinidae and Catostomidae. Development unknown; procercoid stage supposed to occur in body cavity of Tubificidae.

Type species: *Caryophyllaeus laticeps* (Pallas 1781).

To include: *C. laticeps* (Pallas 1781) [= C. mutabilis Rud. 1802]; *C. syrdarjensis* Skrjabin 1913; *C. armeniacus* Cholodkowsky 1915; *C. caspicus* Klopina 1919; *C. fimbriceps* Klopina 1919; *C. terebrans* (Linton 1893).

Caryophyllaeus terebrans (Linton 1893) char. emend.

Specific diagnosis: With characters of genus. Adult parasites frequently embedded in intestinal wall, measuring 5 to 28 mm. in length and 0.8 to 2.5 mm. in width. Neck distinct, slightly narrower than body which is flattened dorso-ventrally. Cuticula 10 to 16μ in thickness; subcuticula 15 to 19μ thick, followed by cortical parenchyma 41 to 56μ in depth. Inner and outer longitudinal muscles present, latter more conspicuous in neck. Testes nearly round, numbering 75 to 85, with maximum diameter from 0.09 to 0.16 mm. Cirrus sac oval to round, occupying one-fourth to one-third of medullary parenchyma. Diameter of same varies between 0.144 and 0.192 mm.; circular muscles of this organ 12 to 19μ in thickness. Male and female reproductive systems open on surface 90 to 96μ apart. Vagina median, ventral, convoluted, and forming receptaculum seminis. Length of ovarian wings varies between 0.6 and 0.7 mm. by 0.2 to 0.3 mm. Maximum diameter of vitellaria 0.228 mm. Eggs are ovoid and measure 55 to 65μ by 30 to 36μ.

Host: *Catostomus ardens,* Heart Lake, Yellowstone National Park, Wyoming. In intestine.

GENUS MONOBOTHRIUM DIESING 1863, char. emend.

Generic diagnosis: Caryophyllaeinae with scolex round to oval in cross section, bearing 6 shallow longitudinal grooves and terminal funnel-shaped introvert. Cirrus and utero-vaginal canal open together into shallow, eversible, common genital atrium, widely separated by bulky annular pad (male genital papilla?). Ovary "H" shaped, entirely medullary. Uterine coils never anterior to the cirrus sac, with maximum length one-third length of testicular field, usually less. External seminal vesicle and terminal excretory bladder present. Post-ovarian vitellaria may or may not be present. Parasitic in digestive tract of Cyprinidae and Catostomidae. Development unknown.

Type species: *Monobothrium wageneri* Nybelin 1922.

To include: *M. wageneri* Nybelin 1922 [= *M. tuba* (v. Siebold 1853)]; *M. ingens,* n. sp.

Monobothrium ingens n. sp. [Figs. 1, 17-20]

Specific diagnosis: With characters of genus. Adult parasites embedded in pits in mucosa of intestine. Length, 45 to 50 mm.; width, 0.9 to 1.2 mm. Neck distinct, 4 to 5 mm. long, 0.69 mm. wide. Longest longitudinal grooves on dorsal and ventral surfaces. Body broadens posteriorly, oval in cross section. Cuticula 5 to 6μ in thickness; subcuticula 10 to 15μ deep, bounded medianly by cortical layer of parenchyma which is 20 to 40μ in thickness. Both inner and outer longitudinal muscle layers well developed, prominent. Testes 300 to 325, roughly ellipsoidal with maximum diameter 0.192 to 0.298 mm. Cirrus sac at an angle of 45° with horizontal, oval, occupying about one-half of medullary parenchyma; maximum diameter 0.35 mm.; circular muscles 12 to 36μ thick. Female genital atrium opens into eversible cloaca, 0.19 mm. posterior to male orifice. Vagina straight, not forming receptaculum seminis. Wings of ovary 0.8 to 1 mm. in length; ovarian commissure 0.19 to 0.3 mm. in diameter. Vitellaria have maximum diameter of 0.18 mm. Post-ovarian vitellaria are absent. Excretory system characterized by 10 pairs of main canals. Eggs measure 53 to 58μ by 28 to 33μ.

Host: *Ictiobus cyprinella,* Lake Pepin, Minnesota. In intestine.

GENUS GLARIDACRIS COOPER 1920, char. emend.

Generic diagnosis: Caryophyllaeinae with three pairs of loculi or bothria on well defined scolex, which may or may not form terminal disc. Cirrus opens on ventral surface or into shallow, non-eversible genital atrium. Ovary "H" shaped, entirely medullary. Coils of uterus never anterior to cirrus sac with maximum longitudinal length one-third of testicular field, usually less. Terminal excretory bladder and external seminal vesicle present. Post-ovarian vitellaria present. Parasitic in digestive tract of Catostomidae. Development unknown.

Type species: *Glaridacris catostomi* Cooper 1920.

To include: *G. catostomi* Cooper 1920; *G. hexacotyle* (Linton 1897); *G. laruci* (Lamont 1921).

Glaridacris catostomi Cooper 1920, char. amend.

Specific diagnosis: With characters of genus. Adults up to 25 mm. in length with maximum breadth of 1 mm.; may be buried in pits in mucosa, though this condition is more typical of larvae. Scolex short, broad and chisel-shaped, length of 0.3 to 0.45 mm. Neck distinct, slightly narrower than body which is flattened dorso-ventrally and bears conspicuous genital atrium. Cuticula 7 to 11μ in thickness, subcuticula 12 to 16μ in depth, which in turn is bounded internally by outer longitudinal muscles. These muscles separate it from cortical parenchyma which has depth of 70 to 84μ. Both inner and outer longitudinal muscles present and prominent. Testes, numbering 405 to 420, irregu-

larly ellipsoidal with maximum diameter of 0.12 to 0.192 mm. Cirrus sac ovoid to spherical, occupies entire medullary parenchyma, possessing maximum diameter of 0.4 to 0.6 mm. Common genital atrium conspicuous, 0.4 to 0.5 mm. in length, 0.7 to 0.16 mm. in depth; female reproductive system opens 0.13 mm. posterior to that of male. Vagina median, ventral, convoluted, forming indistinct receptaculum seminis. Wings of the ovary 0.65 to 0.9 mm. in length; prominent ovarian commissure 0.4 mm. in diameter. Vitellaria with maximum diameter of 0.2 mm.; expanded common vitelline duct functions as vitelline reservoir. Excretory system 8 to 10 pairs of canals with terminal excretory bladder measuring 0.25 by 0.05 mm. Operculate eggs 54 to 66μ by 38 to 48μ.

Host: *Catostomus commersonii,* Douglas Lake, Michigan. In digestive tract.

Glaridacris hexacotyle (Linton 1897) char. emend.

Specific diagnosis: With characters of genus. Adults 8 to 18 mm. in length by 1.03 to 1.2 mm. in breadth. Ridges between 6 loculi form conical apex. Scarcely any neck as vitellaria and testes extend to base of scolex. Body flattened dorso-ventrally, tapering posteriad; in cross section posterior end appears serrated. Cuticula 3 to 5μ in thickness; subcuticula and cortical parenchyma nearly indistinguishable but 5 to 8μ and 12 to 42μ thick, respectively. Inner and outer longitudinal muscles present; latter only few scattered fibers in neck. Testes, numbering 185 to 200, oblong, irregular; maximum diameter 0.14 to 0.26 mm. Cirrus sac occupies about one-half of medullary parenchyma, maximum diameter 0.168 to 0.228 mm.; muscles 14 to 26μ in thickness. Male and female reproductive systems open into shallow, common genital atrium; female 20 to 26μ posterior to male. Vagina convoluted, ventral, forming distinct receptaculum seminis, 60 by 24μ. Wings of ovary have maximum length of 0.8 to 0.9 mm. and width of 0.096 to 0.122 mm. Ovarian commissure "V" shaped, maximum diameter 0.21 mm. Vitellaria with maximum diameter of 0.21 mm. confined to two lateral fields and do not surround testes. Single duct drains group of post-ovarian vitellaria. Excretory canals vary between 8 and 10 pairs ending in terminal vesicle 48 by 24μ. Parenchyma filled with large number of irregular, glandular appearing cells which pack medullary parenchyma from base of scolex posteriad, gradually thinning out as cirrus sac is reached. Specialized muscles of transverse and dorso-ventral sets form circular muscles just internal to inner longitudinal muscle mass. Eggs ovoid, 37 to 41μ by 23 to 30μ.

Host: Catostomus sp. Gila and Salt rivers, Arizona. In intestine.

Glaridacris laruei (Lamont 1921), char. emend.

Specific diagnosis: With characters of genus. Adults up to 7 mm. in length by 0.8 mm. in width, characterized by prominent scolex 0.3 to

0.7 mm. in length, bearing 6 loculi and terminal disc, forming the "II" type of scolex. Disc about 0.06 mm. in thickness; scolex has maximum width below terminal disc of 0.55 mm. Neck distinct, maximum length 0.96 mm. Body oval to cylindrical in cross section, not readily separated into subcuticula and cortical parenchyma which layers together measure 40 to 55μ in thickness. Both inner and outer longitudinal muscles present, latter only in neck where they are very indistinct. Testes irregularly ellipsoidal, numbering between 65 and 80, 0.12 to 0.18 mm. in maximum diameter. Cirrus sac small, circular, and occupies about one-half of medullary parenchyma, with diameter of 0.108 to 0.12 mm. Circular muscles 16 to 21μ in thickness. True genital atrium absent, reproductive systems open flush with surface 12 to 19μ apart. Vagina median, ventral, moderately convoluted, forming distinct receptaculum seminis which measures 96 by 72μ. Wings of ovary 0.5 to 0.7 mm. long and 0.05 to 0.55 mm. wide. Vitellaria do not completely surround testes; maximum diameter 0.1 to 0.2 mm. by 0.03 to 0.05 mm. Excretory system composed of 8 pairs of excretory canals; terminal excretory vesicle 45 by 24μ. Eggs ovoid, nonoperculate, 39 to 42μ by 26 to 30μ.

Host. *Catostomus commersonii,* Green Lake and Lake Mendota, Madison, Wisconsin; Douglas Lake, Michigan. In intestine.

GENUS CARYOPHYLLAEIDES NYBELIN 1922, char. emend.

Generic diagnosis: Caryophyllaeinae with blunt, scarcely broadened anterior extremities, without trace of specialization. Cirrus opens into utero-vaginal canal before it empties into surficial atrium. Ovary entirely medullary, with long wings which join posteriorly behind oötype to form inverted "A." Uterine coils extend anteriad to cirrus sac, with maximum length one-half to one-third of testicular field. Terminal excretory bladder and post-ovarian vitellaria present. No external seminal vesicle. Parasitic in intestine of Cyprinidae. Development unknown.

Type species: *Caryophyllaeides fennica* (Schneider 1902).
To include: *C. fennica* (Schneider 1902); *C. skrjabini* (Popoff 1924).

GENUS BIACETABULUM, n. g.

Generic diagnosis: Caryophyllaeinae with well defined scolex, varying but little in shape, bearing one pair of well defined acetabular suckers, with or without additional loculi. Cirrus opens into utero-vaginal canal before it reaches surficial atrium (as in Caryophyllaeides). Ovary "H" shaped, entirely medullary. Uterine coils extend anteriorly to cirrus sac, with maximum length one-fourth of testicular field, usually less. Terminal excretory bladder and external seminal vesicle present. Post-ovarian vitellaria present. Parasitic in Catostomidae. Development unknown.

Type and only species: *Biacetabulum infrequens,* n. sp.

Biacetabulum infrequens, n. sp. [Figs. 2, 3, 13-15]

Specific diagnosis: With characters of genus. Adults 16 to 22 mm. in length by about 0.6 mm. in breadth. Scolex armed with one pair of acetabular suckers, 0.168 to 0.24 mm. in diameter. Neck distinct, maximum length 0.5 mm. Body oval in cross section and posteriorly appears serrated. Cuticula 4 to 5μ in thickness, followed by subcuticular layer 7μ deep and cortical parenchyma 60 to 70μ in thickness. Inner and outer longitudinal muscles present and fairly prominent in neck. Testes irregularly oval, maximum diameter 79 to 168μ, number 420 to 440. Cirrus sac round, occupying one-third to one-half of medullary parenchyma; maximum diameter 0.144 mm.; muscles 19 to 24μ in thickness. Cirrus opens into utero-vaginal canal 0.05 to 0.8 mm. from ventral surface. Vagina convoluted, forming distinct receptaculum seminis, 105 by 48μ. Wings of ovary 0.608 to 0.658 mm. long; ovary fills medullary parenchyma as ovarian commissure is broad. Vitellaria surround testes, measure 84 to 168μ in length. Excretory system has 8, 10, and 12 pairs of canals which empty into excretory bladder 90μ long by 24 to 36μ in width.

Host: *Moxostoma anisurum,* Rock River, Illinois. In intestine.

GENUS HYPOCARYOPHYLLAEUS, n. g.

Generic diagnosis: Caryophyllaeinae with three pairs of weakly defined loculi on poorly defined scolex. Cirrus opens on ventral surface or into shallow, non-eversible genital atrium. Ovary "H" shaped, entirely medullary. Uterine coils extend anteriorly to cirrus sac, maximum length one-fourth or less that of testicular field. Terminal excretory bladder and external seminal vesicle present; also post-ovarian vitellaria. Parasitic in intestine of Catostomidae. Development unknown.

Type and only species: *Hypocaryophyllaeus paratarius,* n. sp.

Hypocaryophyllaeus paratarius, n. sp. [Figs. 8-12)]

Specific diagnosis: With characters of genus. Adults 7 to 10 mm. in length, 0.15 to 0.3 mm. in width, flattened dorso-ventrally. Scolex bears 6 weak loculi and is roughly wedge shaped. Cuticula 3 to 6μ thick, subcuticula and cortical parenchyma together 30 to 73μ. Medullary parenchyma occupies one-half body width. Inner longitudinal muscles reduced to 8 fasciculi in neck; outer longitudinal muscles only in neck and soon disappear. Tests number 70 to 80, very small, 80 to 100μ in length by 43 to 55μ in width. Cirrus sac occupies two-thirds of medullary parenchyma, maximum diameter 0.105 mm.; circular muscles 12 to 15μ. Male and female reproductive systems open on surface 50μ apart. Vagina straight, forming distinct receptaculum seminis 0.125 to 0.135 mm. in length, very thick walled, being surrounded with circu-

lar muscles of same thickness as those about cirrus sac proper. Vitellaria surround testes, maximum diameter 52 to 73μ. Six pairs of main excretory canals. Eggs small, ovoid, non-operculate, 26 to 32μ by 18 to 21μ.

Host: *Carpiodes carpio, Carpiodes velifer* and *Ictiobus cyprinella,* from Rock and Mississipi rivers, Illinois and Iowa. In intestine.

GENUS ARCHIGETES LEUKART 1878, char. emend.

Generic diagnosis: Caryophyllaeinae with well defined, hexagonal shaped scolex, bearing two bothria-like depressions. Cirrus opens into utero-vaginal canal before it reaches surficial atrium (like Caryophyllaeides?). Ovary "H" shaped, medullary. Excretory system without terminal vesicle, with numerous ampullae at posterior end of body. Uterine coils extend anteriad beyond cirrus sac. Vas deferens expands to form external seminal vesicle. Caudal vesicle carries embryonic hooks. Parasitic in body cavity of Tubificidae. Development unknown.

Type species: *Archigetes appendiculatus* (Ratzel 1868).
To include: *A. appendiculatus* (Ratzel 1868), *A. brachyurus* Mrázek 1908.

SUBFAMILY LYTOCESTINAE, n. subfam.

Subfamily diagnosis: Caryophyllaeidae with sexual apertures and ovary situated in last quarter of body. Inner longitudinal muscles internal to vitellaria which are annularly arranged about muscles in cortical parenchyma. Uterine glands present.

Type genus: Lytocestus Cohn 1908.

GENUS LYTOCESTUS COHN 1908

Generic diagnosis: Lytocestinae in which scolex is unspecialized and not broader than remainder of body. Male and female genital pores open separately on ventral surface and not into common atrium. Two rows of main longitudinal muscles present, outer one cortical and internal to nuclear layer of subcuticula, not external to it. Longitudinal extent of uterus at most one-third that of testicular field. Ovarian follicles cortical; ovarian commissure medullary. Uterus not anterior to wings of ovary which is "H" shaped. Post-ovarian vitellaria absent. Parasitic in Mormyridae and Siluridae. Development unknown.

Type species: *Lytocestus adhaerens* Cohn 1908.
To include: *L. adhaerens* Cohn 1908, *L. filiformis* (Woodland 1923), *L. indicus* (Moghe 1925), *L. chalmersius* (Woodland 1924) and *"Balanotaenia" bancrofti* (Johnston 1924)? [Woodland (1926) is authority for this statement.]

GENUS MONOBOTHROIDS FUHRMANN AND BAER 1925

Generic diagnosis: Lytocestinae with scolex devoid of bothria, but bearing numerous longitudinal furrows and possessing terminal introvert.

Male and female reproductive systems open on surface by two separate pores. Uterus never passes anterior to cirrus sac and is long, regularly wound tube. Post-ovarian vitellaria absent. Ovary is "H" shaped; coils of uterus extend anterior to wings of ovary. External seminal vesicle present. Parasitic in intestine of Siluridae.

Type and only species: *Monobothroides cunningtoni* Fuhrmann and Baer 1925.

GENUS CAPINGENS, n. g.

Generic diagnosis: Lytocestinae possessing definite scolex occupying one-fifth to one-fourth of total body length and bearing one pair of well defined bothria. Vitellaria extend into cortical parenchyma past inner longitudinal muscles, having their origin within medullary parenchyma. Vitellaria form continuous row laterally with post-ovarian vitellarian group. Cirrus opens on ventral surface or into shallow genital atrium which is non-eversible and is anterior to similar atrium of female system. Uterine coils anterior to cirrus sac and reach a maximum length one-third or less that of testicular field. External seminal vesicle present. Parasitic in stomach of Catostomidae. Development unknown.

Type and only species: *Capingens singularis,* n. sp.

Capingens singularis, n. sp. [Figs. 4-7, 16]

Specific diagnosis: With characters of genus. Adult parasites 4 to 8 mm. in length, 1.08 to 1.5 mm. in maximum breadth (which occurs in scolex). Neck indistinct, in reality absent for reproductive organs extend into base of scolex. Maximum body width (exclusive of scolex) 1.23 mm. Body oval in cross section; cuticula 3 to 4μ in thickness; subcuticula 5 to 6μ deep and is followed by cortical parenchyma which is 30 to 45μ across. Inner and outer longitudinal muscles present, latter not prominent. Testes number 210 to 225, maximum diameter 0.06 to 0.108 mm. Cirrus sac round, occupying three-fourths of medullary parenchyma, 0.216 to 0.264 mm. in diameter. Circular muscles of cirrus sac 24 to 36μ in thickness. Male and female reproductive systems open on surface 60 to 70μ apart. Vagina convoluted, not forming receptaculum seminis. Ovary globular, very short, nearly surrounding cirrus sac, 0.25 to 0.35 mm. in length; ovarian commissure extremely narrow, 24 to 36μ in diameter. Oviduct 80 to 90μ in length. Vitellaria take origin in medullary parenchyma but extend past inner longitudinal muscles into cortical parenchyma, 36 to 60μ by 14 to 24μ in width. Excretory canals numerous, 25 to 30 pairs of longitudinal canals in cross section. Excretory vesicle 40μ by 19 to 24μ, lies in horizontal plane. Eggs ovoid, 40 to 45μ in length by 21 to 26μ in width.

Host: *Carpiodes carpio,* Rock River, Illinois, and *Ictiobus urus,* Lake Pepin, Minnesota. In stomach.

SUBFAMILY WENYONINAE, nov. subfam.

Subfamily diagnosis: Caryophyllaeidae with sexual apertures in anterior half of body. Ovary in posterior half. Longitudinal muscles may consist either of one thick layer occupying entire cortex or be split into two layers resembling those of genus Lytocestus. Vitellaria medullary, confined to two lateral rows. Uterine glands absent.

Type and only genus: Wenyonia Woodland 1923.

GENUS WENYONIA WOODLAND 1923

Generic diagnosis: Wenyoninae in which scolex may or may not be specialized. Longitudinal extent of uterus at least equal to that of testicular field. Ovary, medullary, follicular and "H" shaped. Ovarian commissure not reduced. Terminal excretory bladder present. Parasitic in Siluridae. Development unknown.

Type species: *Wenyonia virilis* Woodland 1923.

To include: *W. virilis* Woodland 1923, *W. acuminata* Woodland 1923, and *W. minuata* Woodland 1923.

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Explanation of Plates

a acetabular sucker
b bothrium
bm basement membrane
c circular muscles of cuticula
cs cirrus sac
d ductus ejaculatoris
e excretory canals
ea ascending excretory canals
ed descending excretory canals
g ganglionic mass
i inner longitudinal cuticular muscle
it terminal introvert
l loculus
lc longitudinal cuticular muscle
olm outer longitudinal muscle
om ovarian commissure
ot oötype
r external receptaculum seminis
s seminal vesicle
t testis
u uterus
uv utero-vaginal canal
v vagina
vd vas deferens
vtd vitelline duct

The lines in the figures have the following values: 0.02 mm. in figure 18; 0.2 mm. in figures 8, 9, 10, 14; and 0.5 mm. in all other figures.

Explanation of Plate I

Fig. 1.—*Monobothrium ingens,* scolex.
Fig. 2.—*Biacetabulum infrequens,* scolex.
Fig. 3.—*Biacetabulum infrequens,* frontal section through acetabular sucker.
Fig. 4.—*Capingens singularis,* scolex.
Fig. 5.—*Capingens singularis,* cross section through testes.
Fig. 6.—*Capingens singularis,* cross section through cirrus sac.
Fig. 7.—*Capingens singularis,* cross section through utero-vaginal canal.
Fig. 8.—*Hypocaryophyllaeus paratarius,* sagittal section of scolex, showing inner longitudinal muscles.
Fig. 9.—*Hypocaryophyllaeus paratarius,* cross section through scolex.

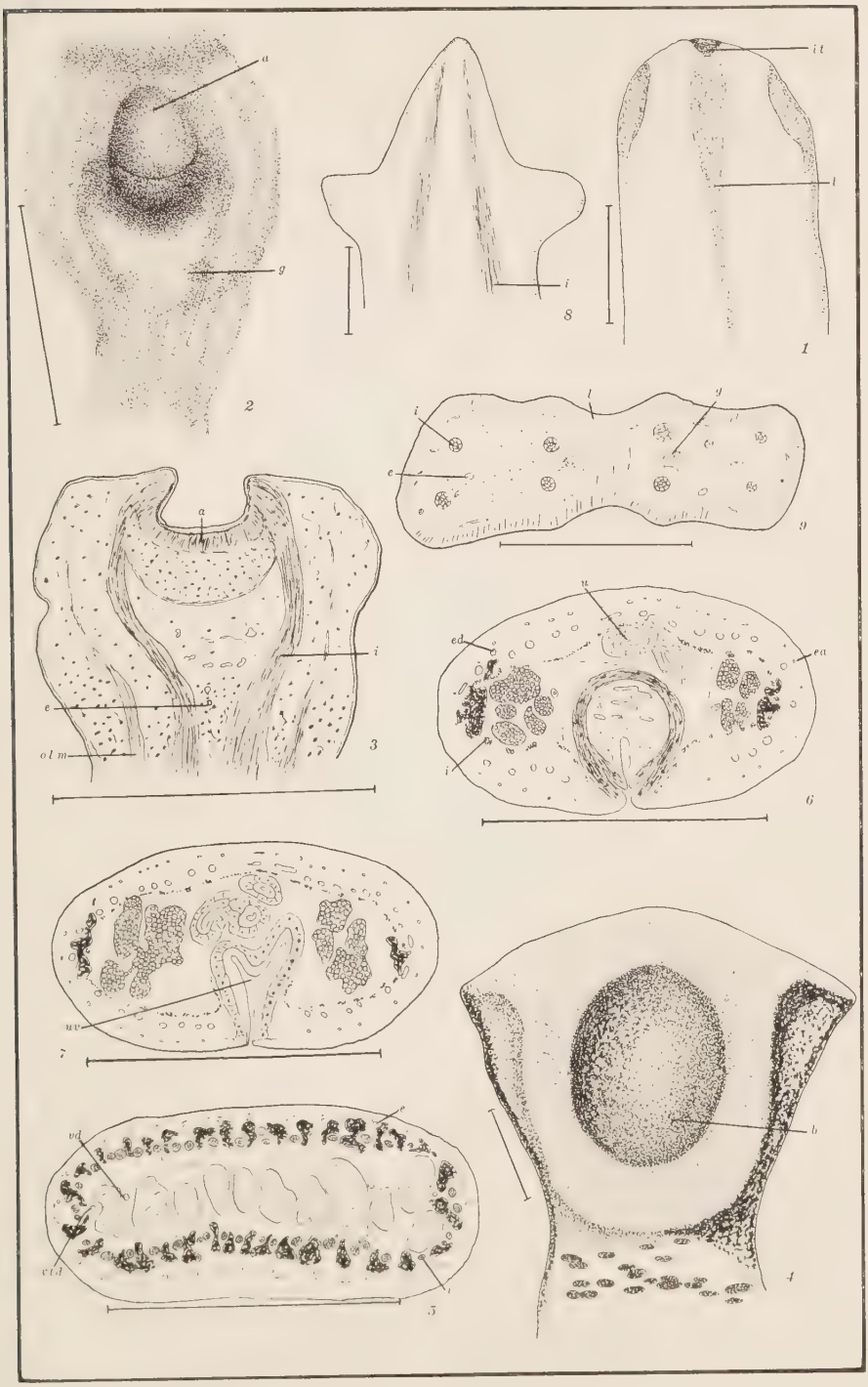

PLATE I

Explanation of Plate II

Fig. 10.—*Hypocaryophyllaeus paratarius,* scolex.

Fig. 11.—*Hypocaryophyllaeus paratarius,* toto, reproductive systems.

Fig. 12.—*Hypocaryophyllaeus paratarius,* sagittal section through reproductive systems.

Fig. 13.—*Biacetabulum infrequens,* toto, reproductive systems.

Fig. 14.—*Biacetabulum infrequens,* cross section through testes.

Fig. 15.—*Biacetabulum infrequens,* sagittal section through reproductive systems.

Fig. 16.—*Capingens singularis,* toto, reproductive systems.

Fig. 17.—*Monobothrium ingens,* toto, reproductive systems.

Fig. 18.—*Monobothrium ingens,* cross section through cuticula.

Fig. 19.—*Monobothrium ingens,* cross section through testes.

Fig. 20.—*Monobothrium ingens,* sagittal section through reproductive systems.

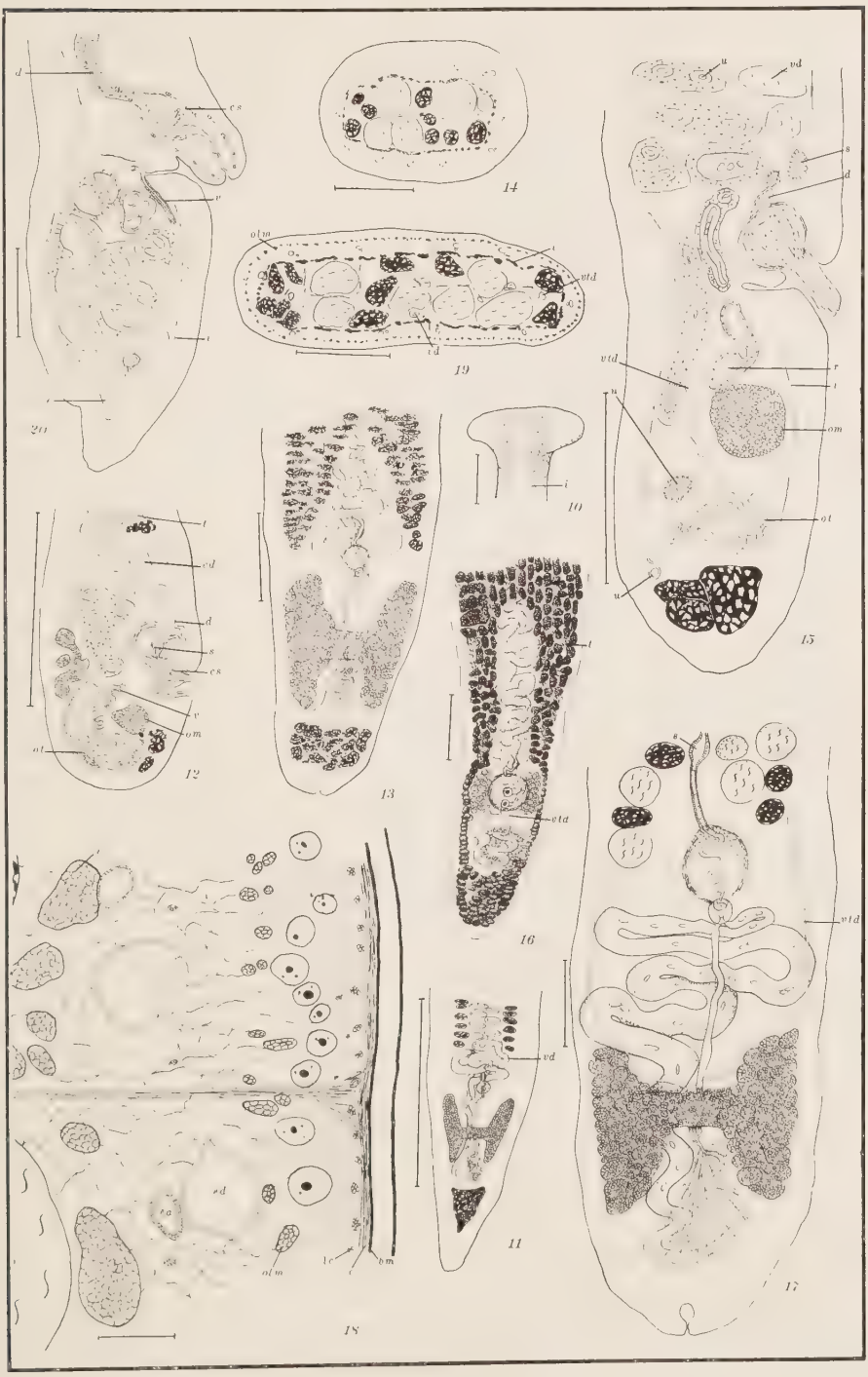
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PLATE II

TRICHOMONADS FROM THE VAGINA OF THE MONKEY

FROM THE MOUTH OF THE CAT AND MAN, AND FROM THE INTESTINE OF THE MONKEY, OPOSSUM AND PRAIRIE-DOG

ROBERT HEGNER AND HERBERT RATCLIFFE
The Johns Hopkins School of Hygiene and Public Health *

In this paper the writers describe by quantitative methods new species of trichomonad flagellates. Trichomonads from the vagina and intestine of the monkey and from the mouth and intestine of man were cultivated in artificial media and studied. Cultures of the species from the vagina of the monkey and from the mouth of man were maintained for several months and a comparison was made of specimens obtained from these cultures at the beginning and end of a 51 day period. A comparison was also made of specimens of trichomonads from the intestine of man before and after cultivation. An attempt was made to obtain cultures of trichomonads from the vagina, mouth and intestine of man for purposes of comparison, but we were unsuccessful in securing vaginal specimens. Among the interesting questions presented by these trichomonads are the following:

Are the trichomonads from these different species of animals specifically distinct?

Is the species from the vagina of the monkey the same as that from the intestine and does the vagina become infected with the intestinal form by contamination?

Do changes occur in cultures comparable to differences in morphology observed in nature?

Trichomonas didelphidis n. sp. (Fig. 1) from the intestine of the opossum was obtained by Dr. Justin Andrews from an opossum shipped to Baltimore from Ohio. Films were fixed with Schaudinn's solution and stained with iron-hematoxylin. Measurements of 60 specimens gave the following results:

TABLE 1

Breadth in Microns	Length in Microns						
	6	7	8	9	10	11	
3.....	1	3	12	22	..	..	38
4.....	..	..	2	10	9	1	22
	1	3	14	32	9	1	60

* From the Department of Protozoology of the Johns Hopkins School of Hygiene and Public Health.

The range in length of these specimens is, as indicated, from 6 to 11μ and in breadth from 3 to 4μ. The mean length was found to be 8.8 $\pm$ 0.077μ, and the mean breadth 3.34μ. As the above table clearly shows, length and breadth are closely correlated; that is, the longer specimens are also broader.

A semi-diagrammatic drawing of a typical specimen is shown in figure 1. The axostyle is not hyalin but stains deeply with iron-hematoxylin; the chromatic basal rod is conspicuous; four anterior flagella are present, each longer than the body; and the flagellum of the undulating membrane extends for a considerable distance beyond the posterior end.

Trichomonas cynomysi n. sp. (Fig. 2) from the intestine of the prairie-dog. We are indebted to Dr. Justin Andrews for prepared slides containing trichomonads from the intestine of prairie-dogs shipped to Baltimore from Ohio. The measurements of 41 specimens are as follows:

TABLE 2

Breadth in Microns	Length in Microns						
	6	7	8	9	10	11	
3.....	3	1	..	..	..	..	4
4.....	..	5	5	1	..	..	11
5.....	..	2	7	3	..	..	12
6.....	..	..	3	3	4	2	12
7.....	..	..	..	..	1	1	2
	3	8	15	7	5	3	41

The range in length is from 6 to 11μ and in breadth from 3 to 7μ. The mean length is 8.2 $\pm$ 0.13μ and mean breadth 5.2μ. The range in breadth is particularly conspicuous and the correlation between length and breadth obviously very high. The shape of this species, as the figure shows, differs markedly from that of the other species described in this paper. The organism is broad and oval; the nucleus is spherical, not ovoid; the axostyle is delicate and stains deeply with hematoxylin; there is a distinct cystostome; the flagellum of the undulating membrane does not appear to extend very far beyond the posterior end of the body; and many specimens contain conspicuous ovoid bodies of unknown nature that stain intensely with hematoxylin.

The difference in length and breadth between the trichomonads from the intestine of the opossum and prairie-dog are indicated in text figure A. The two species do not differ greatly in length, but a conspicuous difference is evident in breadth.

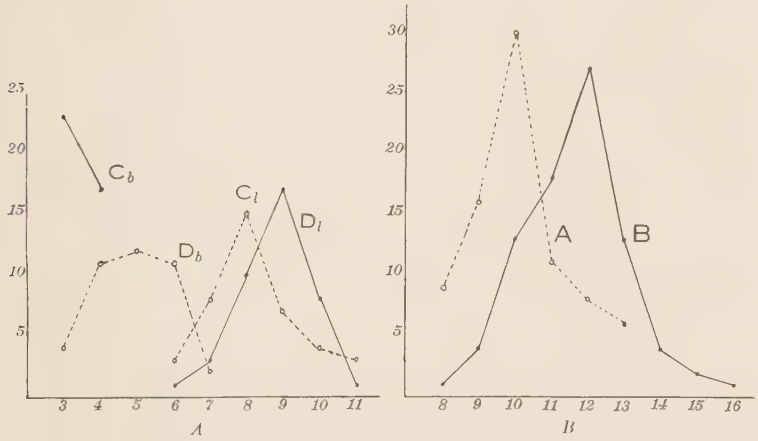
Trichomonas felistomae n. sp. (Fig. 3) from the mouth of the cat. The mouths of two of twenty-eight cats examined contained light infec-

tions with trichomonads. Forty specimens fixed in Schaudinn's solution and stained with iron-hematoxylin gave the following measurements:

TABLE 3

Breadth in Microns	Length in Microns						
	6	7	8	9	10	11	
3.....	1	4	20	3	..	..	28
4.....	..	..	2	5	4	1	12
	1	4	22	8	4	1	40

As shown in this table, the range in length is from 6 to 11μ and in breadth from 3 to 4μ. The mean length is 8.3 $\pm$ 0.98μ and mean breadth is 3.3μ. Here again, as in the case of the trichomonads from the intestine



Vertical lines indicate number of specimens; horizontal lines measurements in microns.

Text figure A.—Curves made from measurements of *Trichomonas didelphidis* from the intestine of the opossum (solid lines) and of *T. cynomysi* from the intestine of the prairie-dog (broken lines). *Db* and *Cb* = breadth and *Dl* and *Cl* = length of *T. didelphidis* and *T. cynomysi* respectively.

Text figure B.—Curves made from measurements of specimens of *Trichomonas macacovaginae* taken directly (*A*) from the vagina of the monkey, *Macacus rhesus*, and from serum-saline-citrate medium (*B*) after a cultivation period of fifty-one days.

of the opossum, length and breadth are closely correlated. The characteristics of this species are shown in figure 3. The organism resembles morphologically the species from the intestine of the opossum and monkey and vagina of the monkey.

Trichomonas macacovaginae n. sp. (Fig. 4) from the vagina of the monkey, *Macacus rhesus*. Trichomonads were obtained from the vagina

of three monkeys maintained in Baltimore by Dr. Carl Hartman of the Department of Embryology of the Carnegie Institution of Washington. These three monkeys were also infected with intestinal trichomonads. Measurements of eighty specimens obtained directly from the vagina and prepared for study in November 1926 are as follows:

TABLE 4

Breadth in Microns	Length in Microns						
	8	9	10	11	12	13	
3.....	8	8	1	..	..	..	17
4.....	1	7	24	6	3	..	41
5.....	..	1	5	5	5	6	22
	9	16	30	11	8	6	80

Cultures were started in serum-saline-citrate medium on Dec. 6, 1926, and subcultures made at intervals of 2 or 3 days for several months. On Jan. 26, 1927, fifty-one days later, slides were prepared from these cultures. Measurements of eighty specimens are as follows:

TABLE 5

Breadth in Microns	Length in Microns									
	8	9	10	11	12	13	14	15	16	
3.....	1	3	1	..	..	..	..	..	..	5
4.....	..	1	12	14	11	..	..	..	..	38
5.....	..	..	..	4	16	9	4	1	1	35
6.....	..	..	..	..	..	1	..	1	..	2
	1	4	13	18	27	10	4	2	1	80

The most obvious change that occurred during the cultivation of these organisms is an increase in size. This is indicated in Tables 4 and 5 which show an increase in maximum length of certain specimens during cultivation, from 13 to 16μ and in maximum breadth, from 5 to 6μ. The mean length of the specimens taken directly from the vagina is $10.1 \pm 0.103\mu$ and that of the specimens from the cultures, $11.6 \pm 0.109\mu$. These differences are indicated in the curves presented in text figure B. The mean breadth of the specimens from the vagina was 4.03μ and of those from the cultures 4.35μ. To determine how significant the differences observed are, the probable error of the difference of the means was worked out; this proved to be $\pm$ 0.47. Since this difference is about three times the probable error the $\times^2$ test was employed to determine the significance of the two distributions. The results of this test indicate that there are only 37 chances in 10,000 that these two groups of organisms belong to the same universe.

Three possible explanations to account for the change observed as a result of long continued cultivation suggest themselves. (1) The

environmental conditions during the life of the organisms in the cultures may have been such as to delay the division process until the individual flagellates grew to a size greater than that possible under conditions while in the vagina of the monkey; or the culture medium may have been more satisfactory for the growth of the organisms thus leading to a larger size before division occurred. (2) The larger specimens originally introduced into the culture medium may have been better able to withstand cultural conditions than the smaller specimens and hence, because of this process of selection of races, the larger flagellates only would leave offspring; these would inherit large size from their parents and pass on this character to their offspring. The mean size of the group might thus be increased as indicated by the measurements. (3) A heritable change in size may have been brought about by the cultural conditions, such as has been obtained by Jennings and other investigators among free-living protozoa by selection. The last explanation seems improbable, the second, possible, and the first probable, but none of them can be established definitely until further experimental work has been done on the problem. It should be mentioned that several investigators have previously noted the development of socalled "overgrowth" specimens of the vaginal trichomonad of man, *T. vaginalis*.

A COMPARISON OF THE VAGINAL AND INTESTINAL TRICHOMONADS OF THE MONKEY

As noted above, the three monkeys from which vaginal trichomonads were obtained were also infected with intestinal trichomonads. A sufficient number of these were obtained, and measurements made to compare with those of the vaginal specimens. Measurements of 80 specimens of intestinal trichomonads made from cultures of fecal material are as follows:

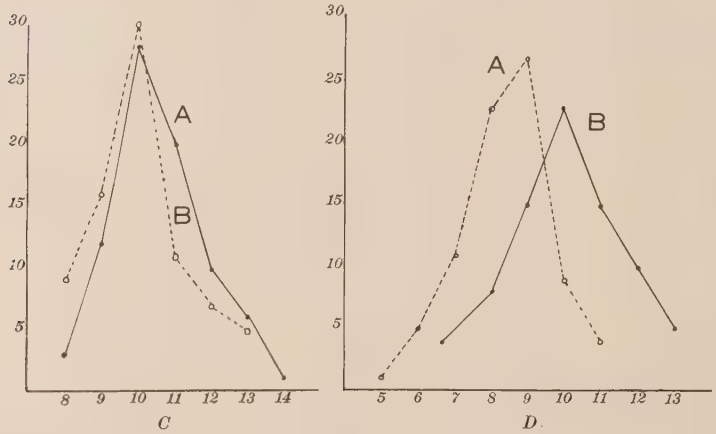
TABLE 6

	Length in Microns							
Breadth in Microns	8	9	10	11	12	13	14	
3.....	3	8	3	..	..	..	..	14
4.....	..	4	24	20	4	3	..	55
5.....	..	..	1	..	6	3	1	11
	3	12	28	20	10	6	1	80

The range in size, and the distribution of the organisms according to size are very much like those of the vaginal form presented in Table 4. The means are as follows: length of vaginal form, $10.1 \pm 0.103\mu$; length of intestinal form, $10.6 \pm 0.094\mu$; breadth of vaginal form, 4.03μ, and of intestinal form, 3.99μ. The curves shown in text figure C indicate that the distribution of the two types of specimens is very similar.

The difference of the means is 0.5μ and the probable error of this difference $\pm$ 0.139. This probable error suggests that the two groups might actually belong to different universes but when the data were subjected to the $\times^2$ test it was found that there are nine chances in a hundred that they belong to the same universe.

The comparison of these two groups of organisms is of particular interest in relation to the problem of the transmission of vaginal trichomonads. Three explanations have been offered to account for the transmission of these flagellates: (1) transmission by contact during coitus, (2) by contact as the result of homosexual practices and (3) by contamination from the intestine. The third explanation would seem the most probable in both monkeys and man provided the intestinal



Vertical lines indicate number of specimens; horizontal lines measurements in microns.

Text figure C.—Curves made from measurements of specimens of trichomonads taken directly from the vagina (*A*) of monkey, and from the intestine (*B*) of the same animals.

Text figure D.—Curves made from measurements of *Trichomonas hominis* taken from fresh fecal material (*A*) and from serum-saline-citrate medium (*B*) after a cultivation period of thirteen days.

species is able to live in the vagina. This, of course, can be determined by experiment and we hope later to have sufficient data on this point to reach a definite conclusion. Anyone who has worked with monkeys realizes how easy it would be for trichomonads from the intestine to reach the vagina without being destroyed, and contamination of the vagina with intestinal bacteria is known to occur in man, especially among children.

Trichomonas buccalis in culture. It was originally intended to make a study of the trichomonads from the mouth, vagina and intestine of man when cultivated in the same medium under similar conditions but lack of material has forced us to reserve this project until later. *Trichomanas buccalis* was, however, obtained in culture and comparisons were made between specimens from a strain prepared on Dec. 6, 1926, and specimens of the same strain prepared fifty-one days later. Table 7 presents the measurements of eighty culture specimens made on Dec. 6, 1926, and Table 8 those of eighty culture specimens from the same strain made on Jan. 26, 1927.

The measurements obviously agree very closely. The mean length of both groups is the same, 10.2μ. These results differ from those obtained when the vaginal trichomonads of the monkey were measured

TABLE 7

Breadth in Microns	Length in Microns (Dec. 6, 1926)						
	8	9	10	11	12	13	
3.....	6	10	9	5	..	..	30
4.....	..	6	19	7	4	1	37
5.....	..	..	4	3	3	3	13
	6	16	32	15	7	4	80

TABLE 8

Breadth in Microns	Length in Microns (Jan. 26, 1927)						
	8	9	10	11	12	13	
3.....	2	11	1	..	..	..	14
4.....	.	6	26	13	4	..	49
5.....	..	..	4	2	5	6	17
	2	17	31	15	9	6	80

at the beginning and end of the same period, as noted above (see Tables 4 and 5, and text figure B), but the specimens of *T. buccalis* measured on Dec. 6, 1926, had been grown in culture for almost a month and had probably undergone during that period changes due to the cultural environment, whereas the trichomonads from the vagina of the monkey prepared on Dec. 6, 1926, were taken directly from the animals.

Trichomonas hominis in culture. Another experiment of this type was performed with the four-flagellated trichomonas from the intestine of man. Eighty specimens were measured that were obtained from freshly passed feces and eighty from the same patient were measured after being cultivated in serum-saline-citrate medium for thirteen days. The data are presented in text figure D and in Tables 9 and 10.

The mean length of those measured before cultivation is $8.4\mu \pm 0.117$ and of those that were kept in culture for 13 days, $10.8\mu \pm 0.199$. The difference between these means is $2.4\mu \pm 0.073$. This is a difference similar to that obtained in the case of the trichomonads from the vagina of the monkey (compare text figures B and D). Evidently a rapid increase in the average size may be expected of trichomonads grown in the culture medium used in our experiments. Explanations of this increase are presented above.

TABLE 9

	Length in Microns (April 20, 1927)							
Breadth in Microns	5	6	7	8	9	10	11	
3.....	1	5	9	9	3	..	..	27
4.....	..	..	2	14	18	5	..	39
5.....	..	..	..	..	6	4	4	14
	1	5	11	23	27	9	4	80

TABLE 10

	Length in Microns (May 3, 1927)							
Breadth in Microns	7	8	9	10	11	12	13	
3.....	4	3	5	..	..	..	..	12
4.....	..	5	9	15	7	1	..	37
5.....	..	..	1	8	8	9	3	29
6.....	..	..	..	..	..	..	2	2
	4	8	15	23	15	10	5	80

DISCUSSION

The genus Trichomonas is much in need of careful study. Its members are widely spread among animals, but very few of them have been adequately investigated. This is in part due to the difficulty of obtaining well-stained material presenting characteristics that can be used for separating species. The various so-called species described from man have not yet been established with certainty and many of the species found in lower animals are still in doubt. The writers may be criticized for giving specific names to the forms described in this contribution, but the decision to do so was reached (1) because of the probability that forms living in different species of hosts are actually distinct species, a probability suggested by the apparently rigid host-parasite specificity of certain other intestinal flagellates, notably giardias, and (2) because of the value of a specific name for reference purposes. It will be very difficult indeed to prove beyond all question the specific distinction of many of the trichomonads, involving, as it does, cross-infection experiments that require the use of animals that are known to be free from infection—material that experience has shown to be almost impossible to obtain. As noted above the specific names proposed by the writers have been selected so as to indicate the host from which obtained, and, in the case of the forms from the mouth of the cat and the vagina of the monkey, the location within the host.

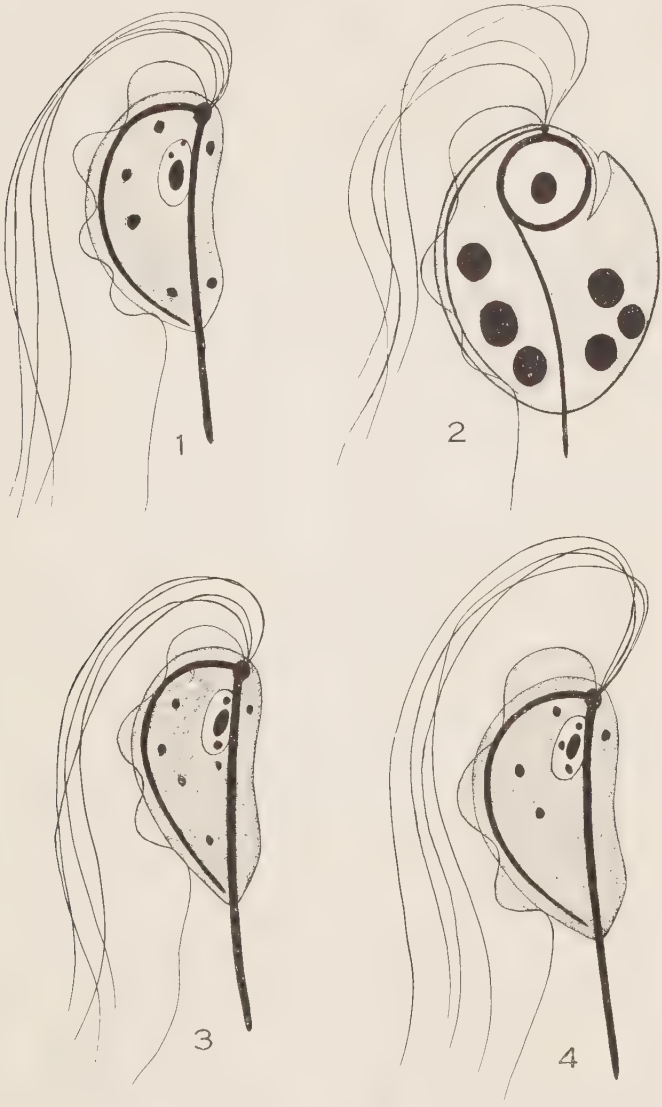


PLATE III

Fig. 1.—*Trichomonas didelphidis* from the intestine of the opossum.
Fig. 2.—*Trichomonas cynomysi* from the intestine of the prairie-dog.
Fig. 3.—*Trichomonas felistomae* from the mouth of the cat.
Fig. 4.—*Trichomonas macacovaginae* from the vagina of the monkey.
Figs. 1-4 are semidiagrammatic and magnified 5000 diameters.

SUMMARY

New species of trichomonads are described as follows: *Trichomonas didelphidis* from the intestine of the opossum, *Trichomonas cynomysi* from the intestine of the praire-dog, *Trichomonas felistomae* from the mouth of the cat, and *Trichomonas macacovaginae* from the vagina of the monkey.

A comparison of specimens of *T. macacovaginae* taken directly from the vagina of the monkey with specimens taken from serum-saline-citrate cultures after a period of fifty-one days showed an increase in size due probably to favorable conditions of nutrition in the culture medium.

Measurement of vaginal trichomonads and intestinal trichomonads taken from the same monkeys showed these two types to be of practically the same size. Since no morphological differences could be found the probability is strengthened that the vagina in both monkeys and man becomes infected by trichomonads from the intestine due to contamination.

No significant differences were observed between specimens of a strain of *Trichomonas buccalis* from the mouth of man that were taken from serum-saline-citrate medium at the beginning and end of a fifty-one day period.

Differences comparable to those noted in specimens of *T. macacovaginae* were found to exist between specimens of *T. hominis* taken from fresh fecal material and specimens of the same strain that had been maintained in culture for thirteen days. The differences in size observed are probably due to changes in the nutritive conditions in the environment.

THE EFFECTS OF ULTRAVIOLET AND INFRA-RED IRRADIATION ON *DEMODEX FOLLICULORUM*

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INTRODUCTION

In the treatment of follicular mange in dogs, the end commonly sought is the destruction or elimination of the invading parasites. Without discussing at length the actual rôle played by *Demodex folliculorum* in the disease, it may be said that the presence of the parasites in the infested skin is an indication of the host's impaired resistance, and a circumstance which often results in secondary infections, auto-intoxication, cachexia and even final exhaustion. The idea seems to be increasingly prevalent that the presence of the hair-follicle mites is a result and not a cause; that such factors as predisposition, degeneracy in breeding, general lack of vitality or debilitating conditions, such as distemper, may be the inciting mechanisms, any one of which can render an animal vulnerable to the invasion of parasites which would otherwise be innocuous.

Whatever may be the true evaluation of the various factors, the diagnosis of demodectic infestation in the dog is usually regarded seriously and therapeutic measures are directed primarily to the elimination of the parasites and secondarily to the maintenance or improvement of the host's general health. Possibly this order should be reversed. In either case, an increase or decrease in the numbers of living demodex in the infested areas of the skin may be considered as one index of the satisfactory or unsatisfactory trend of the disease process. Besides the large number of chemical and pharmaceutical agents that have been employed in antidemodectic therapy, ultraviolet and infra-red irradiations have been reported by a number of workers as producing beneficial and, in some cases, apparently curative action in cases of follicular mange and other diseases of the skin. The majority of the reports have been based on clinical findings only. We have not seen any data relative to the effects of these physical agents on the demodectic parasites in vitro.

While we were observing the effects of ultraviolet irradiation recently in an advanced case of demodectic mange in a dog, studies were made on the effects of heat, ultraviolet irradiation and combinations of the two types of radiant energy on the viability of the demodectic parasites after

removal of the mites from the patient's skin. The subject was a pure-bred St. Bernard male, one year old, in which the disease had progressed for several weeks and to such an extent that much of the head and legs was devoid of hair. Areas of infestation were also distributed over the body from the head to the base of the tail. Secondary infection had already occurred with the formation of pustules particularly about the nose and face and on the legs. Microscopic examination of skin scrapings and of the material expressed from the pustules and from pores of the denuded skin revealed *Demodex folliculorum v. canis* in large numbers (Figs. 1 and 2).

In studying the effects of the selected portions of radiant energy on the parasites in vitro it was necessary to determine, first of all, a means of differentiating dead and living specimens of the parasite and secondly, to determine if the parasites would survive in vitro for long enough time to permit studies to be made. Both requirements were readily met. The demodectic mites which, in the ordinary coverslip preparations made from skin-scrapings or of material expressed from the hair follicles, are either only sluggishly motile or not motile at all at room temperature 20° to 25° C., exhibit considerable sensitiveness to degree of heat somewhat greater than that of the body. That is, parasites which exhibit no movement or only occasional movements of the head or legs at the temperature of the room, show active movements of the head, legs and sometimes of the body when warmed to temperatures of 40° to 45° C. This heating test, therefore, serves as a means of determining the degree or amount of the effects produced by various physical agents on the viability of the demodex parasites.

It was found that parasites included in material obtained from skin-scrapings or in material expressed from the hair follicles remain alive for forty-eight hours or more when this material is carefully applied to cover-slips and the cover-slips then inverted over the wells of depression slides filled with physiologic sodium chloride solution or distilled water, the cover-slips being sealed to the slides with gold size.

GENERAL EXPERIMENTAL PROCEDURE

Drop culture slides, each with cavity about 3 mm. deep, were used and cut to size for insertions in the warming stage attached to the microscope. The depression was filled with physiologic sodium chloride solution at a temperature of 25° C. except as noted elsewhere in this paper. Skin scrapings from the dog (Fig. 3) were obtained and placed on cover-slips. These slips were then inverted and sealed on the slide by means of gold size, due care being taken to avoid the admission of air. In general, we made use of quartz cover-slips (0.5 mm. thick) since it was thus possible to irradiate the skin scrapings with the water or air-cooled mercury quartz lamp. Prior to further experimentation each slide was

examined microscopically to see that at least two or three demodex were living and were sufficiently separated from the mass of skin scrapings to insure the accuracy of subsequent observation. After repeated trial it was found that these parasites remained alive for at least forty-eight hours in physiologic sodium chloride solution or in distilled water at a temperature of approximately 25° C.

Four different sets of experiments, conducted during the period of a week, were carried out to determine the effects of heat, as furnished by the warming stage, on the activity and life of the mites. In general, each set of experiments occupied from one hour to two hours. At a temperaure of 31° to 35° C. (approximately the skin temperature of the dog) the movements of the parasites become fairly marked, at 40° C. more noticeable, at 45° C. very active with subsequent cessation of movement and death in about five minutes at a temperature of about 54° C. The various experiments on the lethal temperatures gave values of 54.5° C., 53° C., 54° C. and 54.5° C. We conclude, therefore, that heat at a temperature of 54° C. $\pm$ 1°, applied for a period of from five to ten minutes, is lethal to *Demodex folliculorum*.

Two experiments were conducted in which the chamber of the culture slide was filled with 1 : 1000 solution of mercurochrome. With progressive rise of temperature in the warming stage it was noted that the mites became very active at 45° C. and began to lose motility at 53.5° C. and were dead after five minutes heating at 54.5° C. Stronger solutions of mercurochrome were not used or investigated because of inability to make microscopic observations under the technic adopted. It is evident that weak solutions of mercurochrome have no effect in hastening the death of the parasites or of causing their death at a temeprature lower than 54° C.

THE EFFECTS OF ULTRAVIOLET IRRADIATION

Three sets of experiments were carried out on different days using skin scrapings smeared on quartz cover slips which were then inverted and sealed to the culture slides, the cells of which were filled with physiologic sodium chloride solution. All slides were examined after preparation to see that at least two demodex were alive. In order to determine this, each slide was inserted in turn into the warming stage kept at a temperature of about 40° C., which we had found was a sufficiently high temperature to demonstrate definite activity of living parasites. We are quoting from our notes a sample set of observations.

Eight quartz cover slips were smeared with skin scrapings, inverted and sealed to the culture slides. All slides showed the presence of several demodex. The slides were then irradiated with an air-cooled mercury quartz lamp (giving a grade 1 reaction or transient erythema of the normally unexposed skin of the upper arm in three minutes when operated at 70 volts at a distance of 50 cm., and a grade 2 reaction or permanent erythema in six minutes) at 90 volts and a distance of 50 cm.

The data obtained from these eight slides are given in Table 1.

These and similar sets of data we believe clearly indicate that the initial effect of ultraviolet irradiation by the quartz mercury arc is stimulative. From one minute to possibly ten minutes of irradiation does not appear to be lethal to the parasites, as observed over a period of forty-eight hours. On the contrary, they appear to be much more active at the temperature of 25° C. (the control temperature of the experiments) after such periods of irradiation than they would be normally at the same temperature. Irradiation under 90 volts and at a distance of 50 cm. for from fifteen to thirty minutes produces lethal effects at the end of twenty-four hours in some instances and general destruction of all directly irradiated parasites follows within forty-eight

TABLE 1.—*The Effects of Various Periods of Irradiation by an Air-Cooled Quartz Mercury Vapor Lamp (Operated at 90 Volts and at a Distance of 50 cm.) on the Subsequent Life of the Mites Demodex Folliculorum*

		Microscopic Examination		
Slide	Period of Irradiation, Minutes	Immediately After Irradiation	Twenty-four Hours After Irradiation	Forty-eight Hours After Irradiation
1	2	All active	Quite active	2 slightly active
2	4	All active	Quite active	3 slightly active
3	6	Few motile	Quite active	3 or 4 slightly active
4	10	Several active	Quite active	Apparently inactive
5	20	Several active	Only 2 active	Apparently inactive
6	30	Several active	3 or 4 slightly active	Apparently inactive. Only active ones were protected by débris. All that had been fully exposed to u. v. were dead
7	Control	Several active	Very active	Several active
8	Control	Many active	Many active, some sluggish	Many active, estimated, 70 per cent of original number are living

hours after such initial periods of irradiation. Objection may be raised that death might be expected to occur in a sufficiently long period of time after removal of the parasites from the host. The different controls, treated in every respect the same as other slides except for the ultraviolet irradiation, showed that death had not occurred from natural causes during forty-eight hour periods of observation. No definite morphologic changes could be demonstrated in the demodex treated with the irradiation from the quartz mercury lamp, although there was some evidence of coagulation of surface tissues in a few instances.

There is considerable evidence to show that coagulation of egg and serum-albumin will take place at temperatures below those at which such effects, as produced by ultraviolet rays, would normally occur. Bovie, in 1918, found that paramecia exposed to a sub-lethal dose of ultraviolet radiation are so sensitized to heat that they cannot stand a temperature which is optimal for controls. With these data in mind, therefore, it seemed desirable to determine, if possible, the temperatures at which death occurred in these parasites which had been irradiated for various periods with ultraviolet light.

In one set of experiments, five slides were prepared; one served as a control while the other four were irradiated five, fifteen, twenty-five and thirty minutes respectively with the quartz mercury lamp operating at 90 volts and at a distance of 50 cm. Each slide was then inserted, in turn, into the warming stage and the lethal temperatures determined in each case. The data are shown in Table 2.

The experimental procedure previously described was modified in another set of experiments by inserting a properly prepared slide (with quartz cover slip holding fifteen or more living mites) into the warming stage ultimately kept at a temperature of from 42 to 45° C. The barrel of the microscope was irradiated for five minutes by the quartz mercury vapor lamp operating at 90 volts and at a distance of 50 cm. After

TABLE 2.—*The Effects of Various Periods of Ultraviolet Irradiation by an Air-Cooled Quartz Mercury Arc Lamp (Operated at 90 Volts and at a Distance of 50 cm.) on the Temperatures which are Lethal to Demodex Folliculorum*

Slide	Period of Irradiation, Minutes	Lethal Temperatures, C.	Remarks
1	Control	52.8	Inserted in warming stage at 34.5 C. Time in warming stage from insertion to lethal effects, 15 minutes. In some instances, movements ceased at 51 C.
2	5	53	Time in warming stage, 10 minutes. Inserted in warming stage at 40 C.
3	15	50	Inserted in warming stage at 39 C. Time in warming stage, 14 minutes
4	25	47	Inserted in warming stage at 36 C. Time in warming stage, 11 minutes*
5	30	44.5	Inserted in warming stage at 35 C. Time in warming stage, 13 minutes†

* When the temperature of the warming stage was 48 C. another mite made its appearance, crawling out from under the protecting débris. From all appearances, this demodex was dead at a temperature of 49 C.

† At a temperature of 46 C. several living parasites came into view, crawling from under the protecting débris. Lethal temperatures in these cases, 48 to 51 C., indicating that they had not been directly irradiated.

irradiation, the slide was examined microscopically. About a third of the parasites appeared to be dead, a few were sluggish and approximately half of the total number were quite active. The slide was then subjected to irradiation of ten minutes, after which all parasites were judged to be dead. The temperature at the conclusion of the observations was 44° C.; the total time of the experiment was thirty-five minutes. A second slide carrying an approximately equal number of demodex and which served as a control, was then inserted in the warming chamber at 44° C. At the end of two hours, all parasites were found to be alive and very active. The following day (after being kept over night at a temperature of approximately 25° C.) the slide was examined at a temperature of 41° C. and apparently all the parasites were alive.

From these and similar observations we believe we are justified in concluding that irradiation of *Demodex folliculorum* with ultraviolet light causes lethal effects at temperatures below those at which death

takes place normally. The greater the amount of irradiation the lower the temperature at which lethal effects occur. If the data given in Table 2 are plotted on coördinate paper, the relationship between the length of the period of irradiation and the lethal temperatures in degree centigrade will be found to be nearly a linear one, and that irradiation of one minute causes reduction of approximately one-third of a degree in the lethal temperature. This statement is to be understood as indicating the order of effect only, because it is doubtless true that the first minute or two of irradiation produce little effect and that periods of irradiation exceeding thirty minutes could not cause a proportionate reduction in the value of the lethal temperature.

Furthermore, it would appear that the simultaneous treatment with ultraviolet irradiation, that is, all irradiation from an air-cooled quartz mercury arc lamp, and heating at a temperature at which the mites are very active (about 45° C.) produces lethal effects more readily than does the experimental condition in which irradiation with ultraviolet light precedes, by periods varying from one hour to twelve hours, the application of heat as derived from either a warming stage or the radiation from a source particularly rich in infra-red energy.

THE THERAPEUTIC EFFECTS OF ULTRAVIOLET IRRADIATION UPON CASES OF DEMODECTIC MANGE

The results obtained in treating cases of demodectic mange in dogs may be stated briefly. The animal from which the materials for the experiments were obtained represented an extremely aggravated case in which the usual forms of treatment almost certainly would have been ineffectual. Accordingly, the dog, after being clipped, was irradiated daily for from fifteen to forty-five minutes with an air-cooled quartz mercury arc lamp operated at 90 volts and at a distance of about 50 cm. No other form of treatment was applied except an occasional cleansing of those areas in which marked secondary infection had occurred. The irradiation was continued over a period of several weeks; during this time the animal's general condition improved markedly but there was no pronounced therapeutic effect on the areas infested with the mites.

In two mild cases of demodectic mange in fox terrier puppies similar irradiation in comparatively few treatments completely arrested the mange. The possibility of spontaneous arrest of the infestation in these cases is recognized but such termination in our experience is not a likely factor.

From the results of our experiments, it seems probable that the benefits of ultraviolet irradiation in cases of demodectic mange cannot be due to any specific lethal effects on the parasites, protected as they are in the deeper layers of the skin; the effects apparently are stimulative

in nature and tend to maintain and improve the general physical tone of the animal and thus help it to overcome the usual effects of the invading parasites.

CONCLUSIONS

1. At about 40° C. the movement of *Demodex folliculorum* become fairly marked under the microscope (× 100) and at 45° C. very marked and active. This furnished a simple criterion by which to select the living from the dead parasites.

2. A temperature of 54° C. ± 1°, obtained either by ordinary heating methods or from infra-red irradiation, applied for from five to ten minutes, is lethal to demodex.

3. Weak solutions of mercurochrome have no apparent effect in hastening the death of the parasites or of causing them to die at a temperature lower than 54° C. ± 1°.

4. Immediately after irradiation with the ultraviolet lamp for from two to twenty minutes there is increased activity of the demodex kept under the initial control temperature of 25° C.

5. Irradiation for from fifteen to thirty minutes by the energy from a quartz mercury arc lamp operated at 90 volts and at a distance of 50 centimeters, produces lethal effects in some instances at the end of twenty-four hours at the control temperature of 25° C. and general destruction of all directly irradiated parasites follows within forty-eight hours after such initial periods of irradiation.

6. Irradiation of the parasites with ultraviolet light, followed by dry heat or infra-red irradiation, causes lethal effects at temperatures considerably below those at which death takes place normally.

7. Simultaneous irradiation with ultraviolet light (from a quartz mercury vapor lamp) and infra-red (heat) energy produces lethal effects more rapidly than does the consecutive application of these two types of irradiation.

8. The daily irradiation of an animal having demodectic mange for fifteen to forty-five minutes with an air-cooled quartz mercury arc lamp, operated at 90 volts and at a distance of 50 centimeters, apparently seems to maintain the general physical tone of the whole animal at a higher level and thereby aids in combating the untoward conditions set up in the host by the invading parasites.

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PLATE IV

Fig. 1.—Reproduction of photomicrograph of *Demodex folliculorum v. canis* (x 60).

Fig. 2.—Reproduction of photomicrograph of *Demodex folliculorum v. canis* (x 200).

Fig. 3.—Reproduction of photograph of dog from which skin scrapings, containing *Demodex folliculorum*, were obtained.

A LARVAL NEMA INFESTING COPEPODS (*PACHYCYCLOPS SIGNATUS*) IN FRESH AND SALT PONDS IN SOUTHEASTERN MASSACHUSETTS

N. A. Cobb *

This describes a larval nema Dr. C. B. Wilson found infesting copepods in a fresh, as well as a salt, pond in southeastern Massachusetts. Doubtless the ultimate host of this larval nema is one of the larger aquatic organisms, such as a fish, and the chances are that the organism is a plankton feeder. Hitherto very few specimens of this larva have been seen; however, this does not necessarily mean that the nema has little or no economic significance. Even should the nema occur in only one individual cyclops in a thousand, or even in ten thousand, nemas might accumulate in the ultimate host in large numbers. A characteristic of plankton feeders is the huge number of organisms of smaller size, microscopic size, they devour in a comparatively short time; thousands at a "meal." It therefore seems best carefully to describe this cyclops parasite, and so facilitate the recognition of the mature form when discovered. The peculiar structure of the larva warrants belief that the adult form, when seen, can be connected with the larva with a reasonable degree of certainty, possibly with great certainty. Persistent research of this character is certain to end in a material increase in present meager knowledge of the nemic parasites of fishes and other aquatic animals.

Cyclopsinema mordens n.g. n.sp. 

The rather thick layers of the transparent, colorless, naked cuticula are traversed by rather uniform transverse striae, difficult of resolution, which are interrupted on the lateral fields by the presence of areas opposite the lateral chords on which the striae are somewhat different and fainter. A very careful examination of the striae indicates that they are resolvable into very faint secondary elements. Slightly oblique longitudinal striae, due to the attachment of the musculature, are rather readily visible in most regions of the body; they also are interrupted by the lateral chords, which appear to be about one-third as wide as the body. On the sides of the neck, as far behind the nerve-ring as this latter is behind the head end, there are two opposite, short, pointed, conoid deirids which may be regarded as 3-jointed (Fig. 1).

The body musculature extends to the region of the cephalic papillae and is distinctly, and probably rather strongly, developed. There are

* Work done in cooperation with the Bureau of Fisheries at its laboratory at Woods Hole, Massachusetts.

two large, simple, equal, lateral lips or mandibles, with external lateral grooves or "valleys" along the middle of their distal parts. Toward the base, these depressions, or "valleys," are wide—appearing to occupy one-third the width of the head. The posterior region of the mandibles, as seen in profile when closed, consists of elements two-fifths as long as the entire pharynx, lying parallel to each other, and in this view occupying a space about equal to one-eighth the diameter of the base of the head. The number of these elements lying side by side remains uncertain but there are at least two, each perhaps duplex. These elements extend forward to that larger portion of the pharyngeal capsule which surrounds the anterior part of the mandibles.

As seen in perfect lateral view, the head is convex-conoid, and then toward the end of the two mandibles almost imperceptibly and slightly irregularly concave-conoid, in contour. The two mandibles can be seen to be located in a head-capsule 20μ deep, the wall of which is of considerable and somewhat variable thickness, averaging approximately

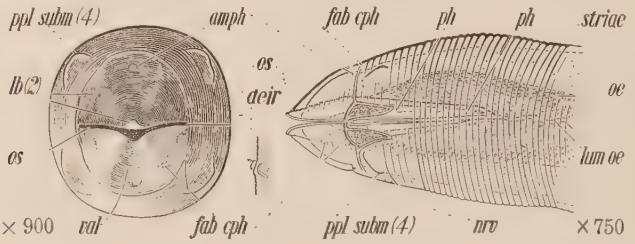


Fig. 1.—Front and dorsal view of head of *Cyclopsinema mordans*, n. sp. with profile view of deirid (*deir*). *val*, external valley or groove in the mandible; *fab cph*, cephalic framework. The other abbreviations are self-explanatory.

about 2μ. In this view the front of the capsule is seen to be faintly separated from the mandibles, and to be nearly as deep as the head is wide; from it there extends backward a smaller part, 9μ deep by 9μ wide, somewhat after the manner of the posterior portion of the pharynx of Bathylaimus, but not, as there, a hollow, empty cavity. Viewed laterally this portion of the capsule appears a little under one-third as wide as the base of the head, as against one-eighth in the other view. In this portion lie what may be called the "roots" of the mandibles. The anterior part of the "exoskeleton," or shell, of the mandibles is very distinctly differentiated—1 to 2μ thick and refractive. At the base of this portion of the mandibles the labial contour extends almost directly backward, both dorsad and ventrad, the marginal refractiveness diminishing as the two contour lines finally pass dorsad and ventrad respectively and fade away. Along the very depths of the exterior "valley" of the mandible there is a narrow refractive element, 0.5μ wide; this

marking can be followed about half way to the bottom of the main portion of the capsule, where it forks, its two branches lying at an angle of about sixty degrees and gradually fading away.

The anterior contour of what has been called the head-capsule is not to be brought into definite focus in the lateral view, and hence in all probability is amalgamated dorsad and ventrad with the surface of the mandible. There is, however, good evidence that the distal ends of the mandibles, even back of the anterior borders of the head-capsule. are not rigidly connected with the capsule dorsally and ventrally. It therefore seems beyond question that the mandibles are capable of a considerable amount of lateral motion.

Viewed dorso-ventrally (Fig. 1) the mandibles appear always slightly opened at their apices. There is no indication of the presence of denticles or ridges, or any other sort of pharyngeal armature. Opposite the base of the larger anterior portion of the pharyngeal capsule containing the mandibles, at the point where in this view the "lips" come together, and at what might perhaps be called the hinge, there is a slight increase in volume of the cutinized matter comprising the outer part of the mandibles, so that in this region the lateral width of the labial structures is somewhat greater than it is a little farther front, yet not so wide as it is some little distance behind the apices of the mandibles. At the summit of each of the four broad flattish cephalic papillae there appears to be a thinning of the cuticula, indicating probably the presence of a minute pore or innervation, probably the latter. The specimen here described was fixed with Flemming's solution and with this fixative the front part of the mandibles appears darker than any other portion, emphasizing the impression that this portion of the mandibles is solid. Following the pharynx backward until the triquetrous arrangement of the esophageal lining comes into view there is no appearance of asymmetry, so that if, as seems probable, the two mandibles are the result of an elimination of a dorsal element in the pharynx, this elimination is very complete.

The amphids are seen more distinctly in front view than in any other, and each may be followed inward and backward until a sensilla is reached; the sensilla is about one-eighth as wide as the corresponding portion of the head, nearly circular in cross-section and resolves so as to show about eight to ten elements. There are no eyespots.

At the base of the pharynx the simple, valveless esophagus is about three-fifths, at the nerve-ring a little more than one-third, and finally more than three-fourths, as wide as the corresponding portion of the neck. There is no distinct posterior esophageal swelling, but there is a distinct increase in the rate at which the organ enlarges in its posterior fourth. The well developed musculature of the esophagus appears somewhat as if segmented, the distance between the marks denoting the

"segments" being about equal to one-sixth the diameter of the neck These markings are more distinct at the axis of the organ, become less distinct near the nerve-ring, and are faint or non-existent in the anterior part of the organ. The lining of the esophagus as viewed in profile is a distinct feature throughout its length and finds its main optical expression as a single axial somewhat sinuous or zigzag element. The outer covering of the esophagus is rather unusually thick and refractive. There is not much pigmented matter among the muscles of the esophagus. The well developed nerve-ring surrounds the esophagus somewhat squarely, and there are obvious nerve cells both in front of and behind it. Behind the nerve-ring there are groups of large ganglion cells of somewhat variable size, the largest of which are one-sixth as wide as the corresponding portion of the neck.

The yellowish intestine, which becomes at once three-fourths as wide as the body, is thick-walled with a moderately obvious lumen, but with no distinctly refractive lining. Farther back the lining of the intestine becomes more refractive, though in the specimen under examination, the lumen is not readily distinguishable, since the walls of the intestine, when viewed in profile are seen to lie in contact with each other. The intestine is made up of cells of such a size that probably about six are presented in each cross section. These cells contain numerous granules of variable size, the largest of which are considerably wider than the annules of the cuticula. There appears to be a sort of collar between the esophagus and the intestine, the main constriction being in front of the collar. The short, blunt tail is conoid from in front of the anus, and tapers more rapidly just behind the anus than farther back; at the terminus it is subtruncate and about one-eighth as wide as at the anus. There is no spinneret. The cuticula on the terminus is a little thicker than it is farther forward. The contour of the terminal portion is a little more distinctly crenate than is the rest of the body. The anus is slightly depressed, and from it the rectum, which is considerably longer than the anal body diameter, and appears to be about as long as the tail, extends inward and more directly forward than usual.

On each side of the tail—lateral, or a little dorsad of lateral—near the beginning of the middle third, there is a cushion-like elevation (phasmid), the main portion of which seems to be a thickening of the cuticle. When brought into optical section the phasmid seems to constitute a rather distinct break or alteration in the cuticular and adjacent tissues; the cuticula is at this point slightly raised, while at the same time the contour of the body wall under the subcuticula is slightly depressed. As these organs occur on the larvae it is presumed that they are not secondary sexual characters, but specific—not associated especially with the male, as might perhaps be thought from their

appearance. The lateral chord contains a considerable number of granular elements along its middle. Near the middle of the nema the number of these collections of granules through a distance equal to the width of the body is a dozen or more. The contours of the lateral chords are very distinct and refractive. Except for the masses of granules just mentioned, the chord appears somewhat "structureless." How much these granules have been altered by fixation remains to be determined, but there is without doubt some alteration. Judging from the optical section the muscular body wall is about as thick as the cuticula; together near the middle of the body they often occupy, in the specimen under examination, two-fifths the body radius. Of this two-fifths, three-fifths is occupied by the muscular layer and two-fifths by the cuticula.

The excretory pore is located behind the nerve-ring at a distance nearly equal to the corresponding diameter of the neck. The duct leading forward and outward to it is fairly distinctly cutinized and is unmistakable when brought into good optical section; from the pore it extends inward and backward at an angle of about thirty to forty degrees until it approaches the esophagus, where, apparently, it forks, the two branches following along the esophagus for a short distance and then becoming lost to view. Structures vaguely seen opposite the rectum lead to the conclusion that there may be anal glands of considerable magnitude—or possibly anal ganglia. These structures consist of five or six cells, constituting groups about one-fourth as wide as the body. The transition from intestine to rectum is readily seen, not only on account of the constriction but on account of the change in color.

The sexual mass is about three-fourths as long as the body is wide, and about one-third as wide as long, and seems to consist of no more than two to four cells, though the exact number is doubtful; certainly small. This group of cells is considerably in front of the middle point between the base of the neck and the anus, the ratio being, distance from the esophagus to distance from the anus as three to four.

The striking features of this larval nema are, (1) the nature of the two-mandibled head, (2) the cushion shaped papillae (phasmids) near the anus, (3) the cylindroid neck, (4) the well-developed musculature, (5) the jointed deirids and (6) the fact that it is found parasitic in cyclops. Examined after fixation in osmic vapor followed by Flemming's solution over night. The specimen from which this description is derived was found by Dr. C. B. Wilson, August 19, 1926, in a specimen of cyclops (*Pachycyclops signatus*), from a fresh water pond at Chatham, Mass. In 1925 Dr. Wilson found it in a salt pond near Falmouth, Mass.

ON A NEW SPECIES OF HYMENOLEPIS FROM A MONKEY

Jean-G. Baer
Zoological Institute, University of Neuchâtel

While examining some material sent for identification by the Zoological museum of Berlin, I came across a bottle containing several fragments of a tapeworm from *Cercopithecus nictitans* (L.), collected in West Africa. The examination of these fragments has revealed a new species of the genus Hymenolepis for which I propose the name

Hymenolepis cercopitheci n.sp.

Host: *Cercopithecus nictitans* (L.).

Distribution: West Africa.

This worm appears to be about 25 mm. long and attains a maximum width of 1 mm. A single fragment possessed a scolex. The latter, measuring about 0.2 mm. in diameter, bears a small rostellum 60μ long and 42μ in diameter, and is armed with a single crown of 27 to 28 small hooks. The shape of the hooks is very characteristic. They measure 13 to 14μ from the tip of the blade to the tip of the handle, and 14 to 16μ from the tip of the handle to the tip of the guard. The suckers are 95μ in diameter.

The musculature of the strobila is very feebly developed. There appear to be about 5 or 6 stout longitudinal fibers. The internal anatomy does not offer any peculiarities. All the segments are much wider than long, the ratio of the length to the width being about 1:12. The three testes occupy the position typical of the sub-genus Hymenolepis, i.e., two testes are aporal and one is poral, all three being in the same straight line. Each testis is about 74 to 76μ in diameter. The cirrus pouch is 0.1 to 0.15 mm. long and 0.04 mm. in diameter. The cirrus appears to be unarmed. The genital pore is situated in the anterior half of the edge of the segment. The vagina lies ventral to the cirrus pouch and very soon swells out to form an enormous receptaculum seminis. The female glands are situated in the middle of the segment. The ovary is 0.23 mm. wide and the yolk gland, situated behind the ovary measures 0.07 mm. across. The ripe ova are somewhat elliptical and measure 38μ by 30μ; the embryos measure 27μ by 23μ.

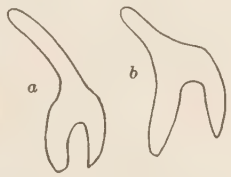
This is the third species of Hymenolepis to be described from a monkey. The other two species being *H. diminuta* from *Cercopithecus smithi* collected in the Belgian Congo (Gedoelst, 1925) and *H. cebidarum* from *Callithrix nigrifrons* collected in South America (see

Baer, 1927 *). Neither of the last two species are armed, so that *H. cercopitheci* is the first armed species to be described from a monkey.

The species most closely related to *H. cercopitheci* appears to be *H. nana*. The following table will render the comparison clearer:

Species	*H. nana*	*H. cercopitheci*
Length	60 mm.	25 mm.
Width	0.5-0.8 mm.	0.5-1 mm.
Diam. of suckers	78-84μ	95μ
Number of hooks	22-27	27-28
Size of hooks	16-20μ by 14-16μ	13-14μ by 14-16μ
Size of ova	48-52μ by 36-45μ	38μ by 30μ

The above differences appear to be slight, but if one compares the shape of the two hooks it appears that they differ very much from one another and that these differences cannot be due to refraction. I consider that these details are sufficient to justify a distinct species. There are actually 44 species of Hymenolepis known from mammals. They inhabit the following groups of hosts: Marsupialia 1 species, Rodentia 22 species, Insectivora 17 species, Chiroptera 3 species, and Primates 1 species. Two species viz. *H. diminuta* and



Text Figure

a. Hook of *H. nana* and *b*. hook of *H. cercopitheci*.

H. nana are common to both rats and man, and the first named species is also found in monkeys. Of the 44 species 25 are armed. The reader may consult a paper by Fuhrmann published in this Journal in 1924, and in which he gives a complete list of all the known species of Hymenolepis together with the number and the size of the hooks of each species. In order to bring the list of species from mammals up to date, *H. longior* Baylis 1922 must be eliminated, as it is a synonym of *H. fraterna* Stiles 1906. There are to be added to the species from Rodentia *H. globirostris* Baer 1925a, and to those from Insectivora, *H. dodecacantha* Baer 1925a and *H. soricis* Baer 1925b nom. nov.†

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* This species along with several other Cestodes was described in a paper sent to press in 1924. However, owing to various difficulties, for which I am not responsible, it will only appear in 1927.

† I described this species from *Sorex alpinus* under the name of *Hymenolepis minuta*. Dr. M. C. Hall has kindly pointed out to me that *H. minuta* is preoccupied by a worm described by Krabbe in 1869 and I therefore propose the name of *H. sorisis* nom. nov.

In a recent and very interesting monograph, Mayhew (1925) has revised the genus Hymenolepis and has attempted a classification based on the disposition of the testes. He distinguishes three groups for which he creates three new genera viz. Hymenolepis, Weinlandia and Wardium. The latter containing all the species in which the disposition of the testes is variable. While recognizing the utility of such a classification one cannot but underline its danger. The presence of the genus Wardium alone denotes the artificial nature of such an arrangement, and I feel certain that when more material has been examined that this genus will disappear. For instance *H. diminuta* is typically *Hymenolepis* but can also be found with the testicular arrangement of Weinlandia or Wardium. While retaining Mayhew's classification for the present I prefer to consider the genera Hymenolepis, Weinlandia and Wardium as sub-genera.

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TRICHOMONADS FROM THE MOUTH OF THE DOG*

Robert Hegner and Herbert Ratcliffe

So far as known to the writers, trichomonads have never been described from the mouth of any species of animals except man. Monkeys, cats and guinea-pigs have been examined in our laboratory with only negative results. Recently, however, 22 of 23 dogs were found to be infected with what appears to be a distinct species. The infected dogs had been maintained in the laboratory for from one month to one year. They were kept, for the most part, in separate cages but allowed to fraternize frequently while the cages were being cleaned. The one negative dog had just been brought into the laboratory from outside. The facts indicate that the infection among these dogs was spread by association during the periods when they were allowed to run about together. The feces of ten of the infected dogs and vaginal mucus from four of them were examined with negative results. The trichomonads were obtained by scraping the tartar from the base of the teeth. The best material was secured from the lower jaw and around decayed teeth.

Description of the organism. Figure 1 shows in semidiagrammatic form the characteristics of the organism. The shape is that of a typical trichomonad. There are four anterior flagella that arise in pairs from a large blepharoplast at the anterior end of the body; these flagella are approximately as long as the body. A fifth flagellum also arises from the blepharoplast, passes along the outer edge of the undulating membrane and then extends out freely near the posterior end a distance about one-half the length of the body. At the base of the undulating membrane there appears to be a chromatic basal rod as in other species of trichomonads. The nucleus is long and slender and completely filled with deeply staining material. The axostyle is thread-like and stains black with hematoxylin, resembling in this respect the axostyles of the trichomonads that have been described from the vagina and mouth of man. It extends for a considerable distance beyond the body at the posterior end. A definite cytostome was not observed, but a light area was noted near the anterior end that may represent such an opening. Deeply staining granules occur in the cytoplasm but no regularity could be made out in their distribution.

The length and breadth of twenty specimens from each of three dogs were measured. There were no significant differences in size

* From the laboratory of Protozoology, School of Hygiene and Public Health, the Johns Hopkins University.

among the specimens from the different hosts. These measurements are given in the following correlation table.

Breadth in microns	Length in microns						Total No.
	7	8	9	10	11	12	
3	1	15	14	9	..	..	39
4	..	..	4	9	7	1	21
	1	15	18	18	7	1	60

There is an evident correlation between length and breadth; those 4μ in breadth are longer than those that are 3μ in breadth. The larger specimens are similar in shape to the smaller specimens and the various sizes encountered probably represent growth stages. The average length is 9μ and the average breadth 3.4μ.

Fig. 1. *Trichomonas canistomae* sp. n. from the mouth of the dog. Semi-diagrammatic drawing showing morphological characteristics. × 5000.

The trichomonads just described from the mouth of the dog differ from those from the mouth of man in various characteristics but principally in size, shape, the length of the axostyle, and the length of the undulating membrane and its accompanying flagellum. *Trichomonas buccalis,* the species from the human mouth, measures from 10 to 15μ or more in length and from 4 to 8μ or more in breadth; its axostyle does not extend out so far from the posterior end of the body; and the undulating membrane is only about one-half the length of the body. The species from man and dog resemble each other in the number and

disposition of the flagella, the single large blepharoplast,* the position, shape, and contents of the nucleus, and the thread-like, deeply staining axostyle. The trichomonads from the mouth of the dog appear to belong to a different species from that living in the human mouth and we, therefore, propose for it the name *Trichomonas canistomae.*

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* Hogue (1926) mentions two, one large and the other small, in *T. buccalis.*

SOCIETY PROCEEDINGS

HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The ninety-seventh meeting was held September 18, 1926.

Dr. Hall gave an account of his work during the past summer in Panama and Nicaragua.

Dr. E. B. Cram presented the following notes:

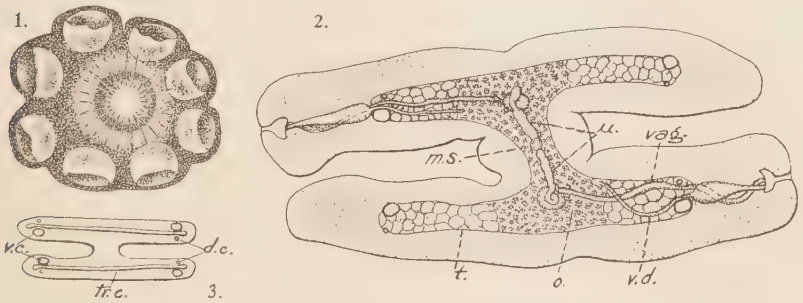
1. New record of *Protospirura bonnei.*—Nematodes from the esophagus and stomach of the rat (species not known) in Manila, Philippine Islands, have been identified by the writer as *Protospirura bonnei* Ortlepp, 1924. The specimens were collected by the Bureau of Science in the examination of rats for plague and were given to the writer by Dr. B. Schwartz. Ortlepp's material was from the rat in South America (Dutch Guiana); his record appears to be the only one up to the present time.

2. A case of abnormal development in *Taenia balaniceps.*—Monstrosities in tapeworms have been reported previously in the form of polyradiate worms. With but two exceptions, all these cases appear to be triradiate or prismatic cestodes, in which there are present on the head 6 suckers instead of 4, and in the strobila 3 leaves or rays so that the cross-section of the segment is roughly Y-shape, but no trace of two sets of organs. This form of abnormality has been found in several species of Taenia, Bothriocephalus, Anoplocephala and Dipylidium, by far the greater number of the reports dealing with *Taenia saginata.* Barker's theory is that such triradiate cestodes are terata arising from the occasional partial and incomplete separation of early blastomeres in embryos of normal cestodes. In addition to these triradiate cestodes, two specimens of *Taenia saginata* have been reported with more than three rays, one report of several segments which were "star-shaped," apparently pentaradiate, the other a report by Foster of a single tetraradiate segment. The internal anatomy of the pentaradiate specimen is unknown; the tetraradiate segment had only one genital pore and one set of genital organs. The nature of the heads of these two specimens is unknown but Railliet had previously anticipated the finding of polyradiate cestodes of more than 3 rays when he found specimens of *Coenurus serialis* having suckers ranging in number from three to ten. The present case deals with a tapeworm sent for identification to the Zoological Division by Dr. George W. Stiles, Jr., the worm having been collected from a 7- to 8-months old Spitz dog in Denver, Colorado. The specimen, approximately 40 cm. long, is a tetraradiate or quadriradiate form of *Taenia balaniceps,* having the macroscopic appearance of two complete tapeworms joined lengthwise in the median line. The head (Fig. 1) is provided with the normal number of hooks (24 large and 24 small hooks) but it has 8 suckers instead of 4; the segments in cross-section are roughly H-shape. Each segment has two genital pores, i. e., each half of the doubled segment has a pore, the two pores always on opposite sides. As regards morphology (Fig. 2), there appears to be a true doubling of the genital organs, each half of the segment containing cirrus pouch, vas deferens, testes (which are not confined to the dorsal side as in normal specimens), vagina and shell gland; the vitellaria and ovaries are merged through the central area, and a uterus arising from either half unites with that from the opposite side to form a median stem extending anteriorly in the central strip. The arrangement of the double set of organs would indicate that the upper half of the section shown in figure 2 would represent one segment and the lower half another segment, but such an assumption is contradicted by the arrangement of the excretory system (Fig. 3). Although the transverse canals extend as two horizontal lines such as would be found in two such segments, the arrangement of the longitudinal canals in the lateral fields is abnormal; instead of the two larger canals of each of these supposed segments being on the same side, which would be the ventral side, they are on opposite sides of the segment, and the same is true of the smaller or dorsal canals. The transverse canals pass between the

two longitudinal canals, are considerably dilated distally and are curved posteriorly to open into the larger or ventral canals. If on the other hand, the alternative interpretation is applied, that the right hand half and the left hand half of figure 2 represent different segments, the transverse canals should form U-shaped loops, passing through the isthmus where the two segments are joined. No explanation that will harmonize the arrangement of the excretory system with that of the genitalia, can be given at present to account for the manner of doubling in this tetraradiate form of cestode.

Dr. J. H. Schuurmans Stekhoven, Jr., contributed the following article [read by Dr. Steiner]:

New facts concerning the larvae of *Ancylostoma caninum* and *Necator americanus*.*—In 1921, collaborating with Mrs. A. W. Schuurmans Stekhoven-Meyer, I studied the infesting hookworm larvae of man and dog (*A. duodenale, caninum, ceylanicum* and *N. americanus*) along biometrical lines in order to find a formula for an easy identification of the different species of larvae, found in infested soil. We also studied the morphology of the above mentioned larvae, but neither the first, nor the second method gave us clear, definite results. Some years later van Thiel published his observations on hookworm larvae comparing larvae of *Ancylostoma caninum* with those of *Necator americanus*. Van Thiel, however (see his paper in *Annales de parasitologie*, Juillet, 1926), is not always clear in



Tetraradiate form of *Taenia balaniceps*.—Fig. 1, Head; view en face. Fig. 2, Cross-section of mature segment. Fig. 3, Diagram of excretory system. *dc,* dorsal canal; *ms,* median stem of uterus; *o,* ovary; *t,* testes; *tr c,* transverse canals; *u,* uterus; *vag,* vagina; *vd,* vas deferens; *vc,* ventral canals.

the explanation of the facts he observed. The main reason why neither he, nor I, in my former work, came to a clear understanding of the structure of the body of this nema, is in my opinion because of the fact that we had no sound knowledge of free-living nematodes before we studied parasites belonging to this group.

Therefore I am very glad to have had an opportunity to acquire a greater knowledge of free-living forms from Dr. Steiner and to study the morphology of some of them in cooperation with him. Afterwards I turned again to my old friends the hookworm larvae. Dr. Shillinger was so kind as to furnish me with necessary material—stools from men and dogs, a culture of Necator larvae and some living *Ancylostoma caninum* females from which I made pure cultures. I then studied the third stage larvae only, most of them still enveloped in their sheaths, which some of them had cast off.

Since most of the important taxonomic characters in nematodes, especially of larval forms, are to be found in the head organs such as amphids, papillae, mouth cavity, etc., special attention was paid to these parts. The head of *Necator americanus* has been carefully described by Cobb to whose figures I refer. The

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*I was enabled to accomplish this study by a traveling Fellowship, granted me by the Rockefeller International Education Board, for which I wish to express my thanks at this time.

mouth cavity is short and cylindrical, passing into the esophagus, the walls of which are bordered by two equally thick, cuticularized rods, each ending in a clasp at its apex. The whole resembles the stamen of grasses with curved pollen sacs. Therefore, it is not like the onchium as Cobb figures it and calls it. This can be proved easily when rolling the larva over. Besides, this structure is not used as a spear. When one observes a larva, which is trying to shed its sheath, the animal tugs at the sheath which shrivels and folds and then suddenly jumps back when the larva loosens its hold. Again the nema tries to break its bars—tugging at another part of the wall. An explanation can be given only by the supposition that the larva gets hold of the skin by sucking it into the mouth cavity. This cuticularized structure remains in the same position meanwhile. In front view the oral opening appears as a more or less rounded aperture; not surrounded by lips.

The amphids are found near the oral opening and have the shape of an unfolding bud, when seen in profile. A median cleft divides them into two parts (see Cobb's figure). The amphidial pouch is tube-like and narrow, slightly widening to the caudal end, where the nerve fibers may be observed clearly. There are four small papillae. Three salivary glands are present, the dorsal one opening into the esophagus at the end of the cuticularized rods. The salivary ampulla is rather wide. Both ventral glands open into the esophagus just in front of the first rudimentary esophageal bulb, which touched the foreborder of the rather narrow nerve ring. The second esophageal bulb is very pronounced; clear rings separate the three more granular sections. The parts of the salivary esophageal glands lying in the esophageal bulb are lobed. Between the bulb *s. str.* and the wide-lumined intestine, one finds a clear space which borders the esophagus at its opening into the intestine and is provided with transverse muscular fibers. It functions as a sphincter without showing cuticularizations as in some free-living nematodes. Cort and Svensson mentioned this structure. Van Thiel is not very clear on the point.

The excretory apparatus is bilobed, not H-shaped; the excretory ampulla which collects the excretory fluid before it is expelled, receives both branches of the gland at its lower end, and from here a curved duct leads to the excretory opening, which is closed by a sphincter. The narrow and long branches of the excretory apparatus reach beyond the junction of the esophagus and intestine. The excretory gland is rather narrow, constricted in the middle. The tail end of the sheath is long, narrow and finely pointed. The tail of the third larva, however, is shorter, and ends rather blunt. The skin of the third-stage larva is distinctly striated transversely; striae not so close together.

Ancylostoma caninum.—The head shows three distinct lips, very obvious in front; mouth opening triangular. The amphids are very distinct, oval, much larger than in Necator and further downward; the amphidial pouch is much wider than in Necator, though fainter. There are four papillae. The mouth cavity is short and narrow. The lumen of the oral end of the esophagus which opens pouch-like into the mouth is bordered by a wall which shows three longitudinal rods of different thickness. At their apices the rods are connected mutually, forming thus a kind of ring, whereas from here into the mouth-cavity two spoon-shaped cuticularizations stretch forward. The dorsal salivary gland opens into the esophagus a short distance ahead of the lower end of the mentioned cylinder. The shape of the ampulla is more slender than in Necator. Both ventral glands open shortly in front of the esophageal nerve ring, at the same spot which Looss figures in his well known monograph. There is no distinct first rudimentary esophageal bulb, yet the esophagus is constricted just in front of the esophageal nerve ring, where the ventral salivary glands open, thus suggesting the anterior bulb. The esophageal nerve ring is much larger and broader than in Necator. The posterior esophageal bulb is not very pronounced. The part of the salivary glands belonging to the esophageal bulb is indistinct, indicated by granules and the three nuclei. A similar sphincter as was observed in Necator is present here but much fainter; the difference to which Cort pointed is therefore not principal, but only gradual.

Svensson described these accurately. The intestinal wall is thick and coarsely granular, the lumen narrower than in Necator. The caudal end of the esophageal bulb is slightly thickened along the walls bordering the lumen. No cuticularized apparatus can be observed as in free-living forms. The excretory apparatus is H-shaped, forehorns short, glands filled with granules, wide at apex and not constricted; hindhorns reaching to about the middle of the esophageal bulb. The excretory ampulla lies almost hidden between the forehorns. The tail of the sheath is much shorter than that in Necator. The tail of the second stage larva is longer and more finely pointed than in Necator. The skin of the second stage larva shows very fine transverse striations; striae much closer than in Necator.

One is inclined to ask what bearing these facts have on the relationship of these parasites with free-living nematodes. The larvae differ widely from Rhabditis in structure of the mouth cavity, number of papillae and structure of the esophagus. Concerning other free-living forms such as Rhabdolaimus, especially *Rhabdolaimus terrestris,* to which these show an unmistakable resemblance, too little is known to establish trustworthy conclusions. Moreover, the adult forms of Necator, as well as of Ancylostoma, up to the present I have not studied, so that further speculation must be postponed.

The ninety-eighth meeting was held October 16, 1926.

Dr. N. A. Cobb contributed the following note on a new nema, *Aphelenchus retusus,* with a proposed division of Aphelenchus into three subgenera: My files contain adequate descriptions of between forty and fifty unpublished new species of Aphelenchus. A review of these files suggests the division of the genus Aphelenchus into three subgenera:

1. *Aphelenchus,* subgen. nov., in the majority of which males are not known, and of which the females, in some cases at least, are syngonic; with very blunt rounded tail end; type, *Aphelenchus avenae* Bast.

2. *Schistonchus,* subgen, nov., a small group, in which the onchium is distinctly cleft at the base; type, *Aphelenchus caprifici* Gasparrini.

3. *Pathoaphelenchus,* subgen, nov., containing the majority of the species; tail more or less pointed; type, *Aphelenchus modestus* de Man.

Aphelenchus retusus n. sp. $\frac{2.2}{1.8} \cdot \frac{13.}{3.4} \cdot \frac{-?}{7-?} \cdot \frac{50-77.}{3.5} \cdot \frac{96.1}{2.5} \cdot 0.72\text{mm}$ In form most like *A. neglectus* Rensch and *A. dubius* Steiner. Apart from striking differences in the measurements, attention is called to the following points in which *retusus* differs from *Aphelenchus dubius* var. *peruviensis* Steiner; (1) the striae are finer; (2) the spear is non-bulbous; (3) the tail is subcylindroid, its terminus subhemispherical with a nearly terminal slightly centrad dimple.

One egg in the uterus at a time, apparently deposited before segmentation begins; body suddenly diminishing a little in diameter just behind the vulva; a clump of syngonic sperms usually occurs a short distance in front of the egg, when the uterus contains an egg; the sperms spherical, refractive and about one-tenth as wide as the body. Male unknown.

Habitat: Dead pupa of a fly, *Chaetopsis aenea,* collected by Mr. A. F. Satterthwaite at Milford, Iowa, September, 1926. Mounted in water the nemas showed no sign of life and apparently were in the early stages of maceration, and hence were not very satisfactory material for examination. It would seem, however, that the specific characters are undoubtedly adequately made out. No male was seen among upwards of 50 specimens.

Commenting on objections to Dorylaimellus as a valid genus, Dr. Cobb called attention, not only to the division of the spear of Dorylaimellus into three distinct segments in series followed by a distinct though relatively slight enlargement of the esophagus, but to the possession by another species, referable to Dorylaimellus, of an excretory pore opposite the nerve ring, and to the fact that the sensillas of the amphids have nearly the same form and location in Dorylaimellus as in Caconema, while in some true Dorylaimi the nerve endings of the sensilla have been seen as a sort of skein located farther forward. As there are hundreds

of Dorylaimi with the preanal supplements more or less regularly arranged, it seems likely that the arrangement of these supplements in twos in Dorylaimellusis not without significance. Dr. Cobb also commented briefly on nemas collected by the Arcturus Expedition, discussing and exhibiting drawings of a deep sea species related to Draconema.

In discussion Steiner pointed out that long, slender appendages are more or less characteristic of, not only deep sea nemas, but deep sea animals in general. Commenting on the peculiar, tubular setae of Draconema and related species, he expressed the opinion that these structures are used in moving "inch-worm fashion" over the floor of the ocean and that the character of the bottom at great depths is of such a nature as to make this possible.

Dr. Steiner discussed and exhibited drawings of the Desmoscolecidae. He called attention to a number of genera, marine forms taken from considerable depths, many of them new to science, which constitute a well defined phylogenic group, ranked by him as a family.

In discussion Stiles parenthetically called attention to the fact that in nomenclature, *Eu* when prefixed to a generic name is frequently understood to designate the typical subgenus. Owing to the possibility of confusion arising thereby, he expressed doubt as to the wisdom of prefixing a recognized generic name with Eu and using the combination thus formed in naming a new genus. Stiles also inquired regarding the probability that a heavy cuticula as found, for example, in the Desmoscolecidae, is a means to resist the pressure encountered at great depths. In reply, Steiner called attention to the fact that the sea around the Kerguelen Islands is constantly lashed by high winds and intermittent storms of great severity, and many of the nemas collected in the shallow waters of this region possess an exceptionally heavy cuticula. In his opinion this is more probably a protection against the action of the surf, and high external pressure is counterbalanced by an internal body pressure. Cobb noted, however, that on the Arcturus Expedition nemas dredged up from considerable depths were subsequently fixed and came through in excellent condition, which seemingly would not have been the case had these forms possessed a high internal pressure.

Drs. G. F. White and W. E. Dove presented a brief report on Creeping Eruption. "We wish to report briefly at this time on the results of further studies on creeping eruption. We have recovered infective nematode larvae in cultures from the feces of the dog and the cat examined from a locality where and when there was a high incidence of creeping eruption. Each of us has applied these larvae to his own skin and produced thereby symptoms and lesions characteristic of and known now clinically as Creeping Eruption. Photographs of some of these lesions are here for inspection. In 26 out of 27 dogs at autopsy and in both of two cats we found hookworms. So far we have identified two species recognized morphologically as *Ancylostoma braziliense* DeFaria 1910 and *A. caninum*. These identifications have been verified by Dr. W. W. Cort. We have been greatly aided in this work through association with Dr. J. L. Kirby-Smith, Dermatologist of Jacksonville, Fla., who has kept us informed regarding the various clinical aspects of the disease and who has referred us to his patients from whom we gained important information as to the location from which their infection had been obtained. A further report on this work will appear in another place."

In discussion White stated that Creeping Eruption is probably always contracted through either direct contact with the ground or from contact in some way with soil. In experimentally producing Creeping Eruption, the larvae applied to the skin have, so far, been obtained from mixed cultures containing both *Ancylostoma caninum* and *A. braziliense*. Stiles recalled that, although he has rarely opened a dog from North Carolina without finding *A. caninum*, Creeping Eruption seldom occurs in that state, seemingly incompatible facts if this parasite is a cause of the disease. Price stated that several cases of Creeping Eruption have been reported from Galveston, Texas, by a local physician, who advocated injecting the infected area with 1/20 grain of strychnine dissolved in 2 cc. of

distilled water. Relative to the time required for the entrance of hookworm larvae, Cort recalled that in the case of *Necator americanus* a stinging sensation is usually experienced about seven minutes after the larva is applied to the skin.

Dr. C. W. Stiles stated that his opinion had been asked in regard to the views recently (1926) expressed by Leiper on the nomenclatorial status of Ascaris. Dracunculus, and certain other nematode names. He plans to reexamine the cases in the light of the premises presented by Leiper and with the original documents before him. Pending this restudy, he reserves judgment, except to invite attention to the fact that Ascaris and Dracunculus are already on the "Official List of Generic Names" and their elimination from that list would require a two-thirds vote of the International Commission. He also invites attention to the principle enunciated in Opinion 93 of the Commission, i. e., "Names now current are not to be discarded unless reasons for change show a clear-cut necessity."

Dr. Benjamin Schwartz stated that in the course of his examinations of undetermined specimens of hookworms from carnivores present in the U. S. National Museum he found *Ancylostoma duodenale* collected from a lion (*Felis leo*) that died in the National Zoological Park, Washington, D. C., in January, 1905. The specimens were collected by Dr. Hassall and were labelled Ancylostoma. Dr. Schwartz also called attention to the presence in the U. S. National Museum of three lots of specimens of *Ancylostoma pluridentatum* collected at various times from Felidae that died in the National Zoological Park. He stated that *Ancylostoma pluridentatum* is a good species and that some of the peculiar features of this worm as noted by Alessandrini in 1905 were correctly described.

Dr. E. W. Price presented the following notes:

1. The occurrence of *Gongylonema verrucosum* (Giles, 1892) in the United States.—*Gongylonema verrucosum* has been collected three times, from the rumen of goats, in this country. Two of these cases were observed by Dr. H. Schmidt at College Station, Texas; one in 1916 and the other in 1920. Specimens from these cases were sent to the Zoological Division of the Bureau of Animal Industry and determinations made by Drs. Ransom and Hall. A third case was found by Dr. S. N. Blackberg at Wheelock, Texas, in 1920, and determination of the specimens made by the writer. This species was first reported by Giles, in 1892, from the rumen of a sheep and zebu. Neumann (1894) restudied these worms and described them in considerable detail. Baylis (1925) restudied the female, and in 1926, the male, of this species and points out certain inaccuracies in Newmann's description, especially the position of the ala. This structure instead of being dorsal is shown by Baylis to be lateral on the left. A study of the specimens collected in the United States has been made and they correspond to the description given by Baylis (1925, 1926) except for the presence of a single ala. Cross sections of several specimens were made and there was found to exist a low ala on the right side as well as a large wavy left ala. This right ala commences at the right cervical papilla and extends backwards, but owing to the difficulty of following it in whole specimens, its termination could not be made out. At the present time this parasite is known from India, South Africa, and the United States. Its distribution in this country is so far as known limited to Texas, and was probably introduced into this state through importations of Brahman cattle from India.

2. A second case of *Ancylostoma braziliense* from Texas.—A single immature female specimen was found in a lot of hookworms collected from a mongrel dog at College Station, Texas, Aug. 13, 1925. The finding of this case in a locality quite distant from the locality from which the first case (Price, 1926) was reported would tend to indicate that, if a careful examination were made, *A. braziliense* is probably not an uncommon parasite of carnivores in the southern states.

3. Posterior paralysis in a pig due to *Stephanurus dentatus* in the spinal canal.—During the spring of 1922, a pig belonging to the Agricultural and Mechanical College of Texas became paralyzed in the hind quarters. This animal

was treated at the Veterinary Hospital for several weeks but without improvement. An autopsy was made and a heavy infestation with *S. dentatus* was found. In addition to lesions in the kidneys, perirenal fat and lumbar muscles, a large greenish caseous lesion was found in the lumbar part of the spinal canal which caused a compression of the spinal cord.

Paralysis of the posterior extremities in pigs is quite common in the southern states and it is not unlikely that a high percentage of these cases are due to Stephanurus infestation.

4. An unusual occurrence of an Ascarid in feces.—An interesting specimen was found in a hog lot at College Station by a student and placed in the pathological museum of the college. This specimen consisted of a female *Ascaris lumbricoides* around which had formed twelve fecal pellets giving it the appearance of a string of beads.

Dr. E. A. Chapin presented the following note:

The new name *Nanophyetus* is here proposed to replace *Nanophyes* Chapin 1926 nec *Nanophyes* Chaudoir 1845. The type species is therefore *Nanophyetus salmincola* (Chapin 1925).

The ninety-ninth meeting was held November 20, 1926, at the School of Hygiene and Public Health, Johns Hopkins University.

Mr. H. W. Brown presented notes upon the epidemiology of human Ascaris infection in Panama. [See Journal of Parasitology, 13:206, Dec., 1926.]

Dr. R. W. Hegner reported on Vaginal Trichomonads in the Monkey.—Three rhesus monkeys belonging to the colony of Dr. C. G. Hartman of the Department of Embryology of the Carnegie Institution of Washington have a vaginal infection with trichomonads. These have been present for several months and are, therefore, persistent inhabitants of the vagina of the monkeys. They have been grown in culture. Whether they represent a species distinct from *Trichomonas vaginalis* of man is yet to be determined.

Dr. J. A. Scott presented the following notes:

1. A method for the recovery of small helminths from organs of hosts.—The recovery from the body of the host of helminths too small to be seen by the aid of a hand lens has been a tedious operation. A preliminary report can now be made of the use for this purpose of the Baermann isolation apparatus. Organs of the alimentary tract are cut open and placed in the cloth-lined sieve in a funnel containing water at 45° C., care being taken not to allow rolling so as to cover any part of the mucous surface. Lungs and liver are cut in small pieces or thin slices and treated in the same way. After 15 or more hours the lower portion of the fluid is drawn off into a centrifuge tube. After sedimentation the worms are counted by a method to be described later.

By this method there have been recovered small flukes, minute tapeworms, and various developmental stages of several species of nematodes. The principal use has been for *Ancylostoma caninum* from dogs, cats, and rats. Forms retaining larval characteristics are easily recovered. Infection of rats *per os* with these hookworm larvae and isolation within short periods of time has resulted in the recovery of an average of 60% of the number given. Of these same worms, counted and placed free in the apparatus an average of 85% can be recovered. Whether this difference of 25% is due to inefficiency of the apparatus, migration of the larvae into the tissues, or their death immediately on entering the host is not yet determined. Somewhat similar conditions exist in cats and dogs. From these animals primitive buccal capsule and early sexual stages are also constantly recovered, but it is not yet certain how efficient the apparatus is in respect to these forms. Experiments are now under way to test this point and to further define the efficiency for larval stages.

2. A device for counting hookworm larvae.—A plate glass slide 3 x 1½ x ¼ inches was made by a local plate glass company. Through the center of this a

groove 3/16 inches wide and 3/32 inches deep was cut and polished. The nature of the grinding machine caused the bottom to be somewhat concave which gave the larvae a tendency to settle away from the edges and become more easily visible. Larvae are placed in the groove in a convenient amount of water or in .5 cc. quantities in the case of dilution counting. A binocular dissection microscope with low power lenses will cover the width of the groove. By the use of a mechanical stage the length of the groove can be covered very quickly and the worms counted on a hand counter. Numbers up to 300 can be counted accurately in the slide. After use the larvae can be poured and rinsed into a tube if they are to be preserved and the slide quickly wiped dry.

3. Hookworms which fail to develop in their normal hosts.—In dogs infected experimentally with *Ancylostoma caninum* a varying number of worms develop to maturity. The use of the Baermann isolation apparatus as previously described has made it possible to determine that a certain number of the worms remain in the host with no noticeable development. They are present up to 33 days after infection; longer periods have not yet been tried. Morphologically they are indistinguishable from infective larvae and careful measurements show that they undergo slight if any increase in size. In cats the same condition is present but is more pronounced, in that a smaller percent develop to maturity and consequently more remain undeveloped. The undeveloped forms are present up to at least 44 days. In rats no development takes place and the larvae can be recovered in decreasing numbers up to 14 or more days. That these experiments are well controlled is indicated in several ways: duplicate units of apparatus have been run repeatedly as controls and were always negative; a number of animals kept under conditions similar to the experimental animals and isolated simultaneously with them were constantly negative. If the presence of these undeveloped forms so long after the infection of a normal host is merely an expression of lag, development must be quite rapid once the inhibition has been overcome. After a period when those that develop normally are coming to maturity, forms in the primitive buccal capsule and early sexual stages are seldom if ever found. Experiments are now in progress to test this point and to determine whether these worms which do not develop in the normal host can do so if transferred to another individual. Similar experiments in relation to abnormal hosts are also projected. Dr. Scott's remarks were accompanied by an exhibit of his apparatus.

Miss Septima C. Smith discussed Excystation of *Iodamoeba williamsi* in vitro and in vivo.—The process of the escape of the motile human entozoic amoeba, *Iodamoeba williamsi*, from its enveloping cyst membrane has never been described. The whole process, from the earliest activity of the amoeba inside the cyst wall to its complete exit, leaving the empty cyst membrane behind, has been observed by the writer many times in washed cysts confined under a cover glass. The conditions necessary for excystation have been studied and the process can be brought about at will by supplying the proper stimuli. Excystation occurs when washed cysts are injected into the stomach of the guinea-pig. It has been noted in the duodenum and jejunum. The excysted amoebae apparently do not find the guinea-pig intestine a favorable habitat since they cannot be recovered later.

Dr. Stiles invited attention to the interpretation by his friend, Professor Richard Heymons (1926; 70), that under the Law of Priority the specific name *rhinaris* Meyer, 1789, would take priority over *Linguatula serrata* (Froelich 1789), but that Heymons did not accept *rhinaris*. Dr. Stiles has not been able to obtain Meyer's (1789a translation of Chabert's book, but cited Art. 28 of the Rules "If the names are of the same date, that selected by the first reviser shall stand." Under Art. 28, Stiles, on basis of the premises as cited by Heymons, now selects *serrata* 1789 in place of *rhinaris* 1789, and unless it be shown that *rhinaris* was published earlier than *serrata* in 1789, this settles the difficulty pointed out by Heymons.

Dr. C. A. Herrick reported that live hookworms, *Ancylostoma caninum* could be successfully transferred from one dog to another. The worms removed at

autopsy were placed in gelatin capsules and given by mouth to a new host without any apparent detriment to the parasites. The transfers were made to obtain the egg output of a single female hookworm in dogs of different ages, kept under varying conditions. Six out of seven attempts were reported to be successful and in one case a female was transferred twice without causing any diminution in her egg laying ability even on the day of transfer.

Dr. N. A. Cobb and J. R. Christie presented a preliminary note on Rhigonema (Isacis, Skrjabin 1914; (?) Isacis, Baylis and Daubney 1926; nec Isacis, Lespés 1856). Nemas inhabiting the intestine of Myriapods.—The first Rhigonema adequately described was *Ascaris infecta* Leidy 1849, from North America; a second one, *Rhabditis acuminata* D'Udekem 1859, from Europe; a third, the type species, *Rhigonema brevicolle* Cobb 1898, from Australia; a fourth, *Isacis multipapillata* Skrjabin 1916, from British East Africa. These rhigonemas constitute a very distinct and easily recognized homogeneous generic group.

Isacis and Rhigonema. The rhigonemas have been wrongly referred to Isacis, Lespés 1856. We consider it impossible, from the literature or in any other way, to satisfactorily determine the nema from the investigation in which Lespés proposed his insufficiently characterized genus Isacis, and therefore think the name Isacis should be abandoned. The various efforts to rehabilitate it have resulted only in additional uncertainty and confusion. Of the well founded nemic genera established, some of them before the date of Lespés' article, some of them later, there are several to which Lespés' nema might conceivably be assigned, but always with so much uncertainty as to make such a course wholly impracticable, e. g., Diplogaster, Rhabditis, Anguillula, one or more of the Oxyuridae, and several others.

While the features described by Lespés are inadequate for the characterization of either a species or a genus, they are ample, in our opinion, to exclude from Rhigonema any species having them. Yet Skrjabin carefully described a Rhigonema, his *R. multipapillata,* and referred it to Isacis Lespés; (perhaps following Diesing, a course we are unable to understand, for it is very manifest that Diesing's Isacis Lespés designates a practically meaningless collection of either unrecognizable or incompatible forms). The same course has been followed by Baylis and Daubney, whose text seems to indicate that they used Skrjabin's description as a main source for the characterization of *their* Isacis Lespés.

The one hundredth meeting was held December 18, 1926. Dr. M. C. Hall was reelected as the society's representative to the Washington Academy of Science.

In the absence of the author the following paper was read by Dr. Schwartz:

THE POSSIBLE PRESENCE OF MALE SCHISTOSOMES ALONE IN EXPERIMENTAL AND NATURAL INFECTIONS*

ERNEST CARROLL FAUST

Cort (1921) has postulated the theory that "sex in the schistosomes is differentiated in the miracidium stage, and that all cercariae which develop from a single miracidium are of the same sex." This hypothesis is based in part on the observations of several investigators who have found that experimental infections of mammals with *Schistosoma japonicum* cercariae from single snails usually yield schistosomes of one sex, the worms in such cases being unable to mature. In an attempt to secure a supply of adult *Schistosoma japonicum* for teaching purposes the writer has utilized cercariae obtained from *Oncomelania hupensis,* collected by Dr. C. F. Wu from several localities in the immediate vicinity of Soochow at five successive periods from March to September, 1926. In view of the prolonged dry season snails of this species were uncommon, but some ten

* Contribution no. 81 from the Parasitology Laboratory, Department of Pathology, Peking Union Medical College.

thousand living snails, representing all those found in the area by Dr. Wu during the entire season, were collected and sent to the writer. They were gently crushed one at a time in a mortar and on examination yielded altogether twenty individuals infested with cercariae of *Schistosoma japonicum* (i. e., 0.2 per cent infection). Rabbits or dogs were submitted to infection with hundreds of viable mature cercariae from each collection, as indicated in the accompanying table. In all instances the hosts which had become infected yielded at auptosy from one and a half to five months later only immature male worms, the numbers found varying from thirty-three to one hundred and sixty-five individuals. In previous experimental infections with Schistosoma cercariae from snails collected in the Soochow area no consistent series of only male or only female worms has been obtained.

According to Cort's hypothesis these results would indicate that the parasitic progeny of the snails utilized must have been derived solely from male miracidia. It is conceivable, however, that the dry conditions prevailing in the area may have

Experimental Data on Infection with Male Schistosoma japonicum *in* Oncomelania hupensis *and in Mammals*

No. of Snail Collection	No. of Snails in Collection	No. of Infected Snails	Animals Exposed to Infection	No. of Infected Snails Utilized	No. of Worms Found at Autopsy
1	2500	5	rabbit	1	♂ 33, ♀ none
			rabbit	2	♂ 93, ♀ none
			rabbit	1	♂ 36, ♀ none
2	1500	2	dog	1	♂ 165, ♀ none
			rabbit	1	♂ 49, ♀ none
3	2300	5	rabbit	2	♂ 156, ♀ none
			rabbit	1	♂ none, ♀ none
			rabbit	1	♂ none, ♀ none
4	1200	3	rabbit	2	♂ 44, ♀ none
			rabbit	1	♂ 62, ♀ none
5	2500	5	dog	2	♂ 87, ♀ none
Total	10000	20	rabbits 9 dogs 2	15	♂ 725, ♀ none

been more severe on the female than on the male parthenitae within the snails. While no sweeping conclusions can be drawn from these results, they suggest the possibility that within the immediate area of Soochow during the past season only male worms survived. Natural human infections acquired under such conditions would probably have consisted only of male worms.

Purely male infections can obviously not be diagnosed by the recovery of eggs from the feces. As far as the writer knows, the pathological and clinical aspects of such an infection are entirely unstudied. It seems quite certain, however, that male worms alone, even in heavy infections, would not have the same destructive action on the liver and intestinal tract as that produced by a bisexual infection where eggs were periodically being extruded into the tissues. Nevertheless numbers of male worms might at times obstruct the mesenteric radicles, while their secretions or excretions might occasion an appreciable eosinophilia. It is highly desirable that suspected Schistosoma cases in endemic areas, where stool examination is consistently negative, be studied in the light of the possibility outlined.

Dr. J. H. Sandground reported on the occurrence of helminth infections among the native inhabitants of South Africa [read by Dr. Schwartz]. Although considerable information regarding this matter is available, an exhaustive survey of the field is needed, especially in the matter of human infections with nematodes. Despite the widespread opinion among those in Johannesburg interested in the question, that hookworm infection among the kafirs recruited as laborers on the

Transvaal gold mines, is a rarity, and when found is of little clinical consequence, Turner (Jour. Trop. Med. and Hyg., 13:50-59, 1910), in a systematic postmortem examination of 746 natives of various tribes who died while employed on the mines, found 351 cases of infection with hookworms (both *Ancylostoma duodenale* and *Necator americanus*). On the other hand, Porter in a more recent survey of the intestinal entozoa among natives in Johannesburg (S. Afr. Inst. Med. Res. Publ. XI) in a large series of examinations reports the finding of hookworm only once, and that in postmortem examination.

During a short sojourn in Johannesburg last summer, Dr. A. J. Orenstein, Director of Sanitation in the Rand Mines, courteously permitted me to examine the stools of native mine workers who were receiving treatment in hospital. Lack of time and equipment allowed me to make but a scanty survey, and I was only able to examine stools of 46 natives. These natives picked at random, belonged to 6 different tribes whose homes were in Bechuanaland, Mozambique (Portuguese East Africa), the Transvaal, and British Kafraria (Eastern Cape Province) where the infections probably originated. The stools were examined once only by simple smear and by the Willis flotation method. In only 8 of these 46 cases were helminth infections not demonstrable. The following parasites were observed: *Taenia solium* or *T. saginata,* 2 cases; *Trichuris trichiura,* 3 cases; *Strongyloides stercoralis,* 3 cases; *Ascaris lumbricoides,* 9 cases; *Enterobius vermicularis,* 1 case; Hookworm (Ancylostoma or Necator), 22 cases; *Schistosoma haematobium,* 3 cases; *Schistosoma mansoni,* 2 cases.

In one case, a man of the Ama-Xosa tribe (British Kafraria), the following parasite eggs were found in smears: hookworm, Ascaris, Trichuris, Enterobius, Taenia sp., *Schistosoma haematobium,* and *S. mansoni.* Various reasons prevented my securing any complete anthelminthic treatments of cases and I cannot pass opinion on the intensity of infections. Yet I have no doubt that a number of the infections were relatively severe. In one case in which hookworm had been recognized and which had already received treatment with thymol, an exceedingly large number of hookworm eggs was still present in the stools. This case gave a wonderful picture of profound anemia. Dr. Walter Fischer made two red blood cells counts of the case, the results of which showed 750,000 and 800,000 R.B.C. per c.m. respectively.

Dr. L. H. Vidhikar reported a note on charcoal cultures for hookworm larvae [see Journal Parasitology, 13:195, Dec., 1926].

Dr. Wm. A. Riley called attention to the prevalence of trichina in cats stating that in his experience these animals constitute an excellent source of trichina for laboratory purposes.

Dr. W. W. Cort commented briefly on progress made by the American Society of Parasitologists and reported in this connection the formation of a China Branch with 37 members, meeting in Peking.

The nomenclatorial status of scientific names occurring for the first time in the programs of the American Society of Parasitologists was discussed.

Dr. N. A. Cobb presented the following notes:

1. A thermolethe, a device for fixing organisms in warm or hot solutions, especially in those containing vaporizable or inflammable ingredients.

2. Myolabia; hitherto undescribed pseudolabia occurring on a new nema parasite in Millipeds.

3. Syngony in a new parasitic nema found in Millipeds [to be published elsewhere].

In discussion, Dr. Cobb called attention to a series of locational terms for the cytology of descent that are being used with increasing satisfaction. Just as "cone" and "conic" evolved from kovos, "gone" and "gonic" are derived from govos. "Gone" is applied strictly to the *generative* portion of a sexual organ, being less general than "gonad," which, as ordinarily used, includes some somatic elements of the generative organ. By metonomy "gone" designates an organism

or species having gones; thus there are two kinds of organisms—"gones" and "agones." From "gone" come the verb "to gone" and the substantives "syngone," "digone," "amphigone," "homogone," and "heterogone." From syngone come the words "syngonic," "syngonically," and "syngony;" and corresponding words from digone, amphigone, homogone and heterogone.

Gone. To produce one or more gones.

Gonic. Of or relating to a gone.

Syngonic. Having macro-("female") and micro-("male") gametes in the same gone; e. g., as in many nemas.

Digonic. Having macro-("female") and micro-("male") gametes in separate gones in the same individual; e. g., as in many hermaphrodites.

Amphigonic. Having macro-("female") and micro-("male") gametes in separate gones located in separate individuals; e. g., as in all bisexual forms.

Homogonic. Having gones all of the same kind.

Heterogonic. Having gones of various kinds; e. g., as in a species presenting both syngony and amphigony.

Syngone. A gone bearing both macro-("female") and micro-("male") gametes. By synecdoche syngone also designates an organism or species containing, or characterized by, syngones; similarly with the following four terms.

Digone. A digonic individual or species.

Amphigone. An amphigonic species.

Heterogone. A species presenting both amphigony and syngony, or both digony and amphigony, etc. A heterogonic species.

Homogone. A species or individual presenting uniformity in the space relationships of its gonic cells. A homogonic species.

Kinetogone. A gone whose gametes are active, aggressive, or "male."

Statogone. A gone whose gametes are passive or "female."

Sir E. Ray Lankaster (Nature, Aug. 23, 1917) and N. A. Cobb in Notes on nemas, May 8, 1917, have called attention to the incompleteness and lack of precision in what is still the usual terminology in this field.

Dr. E. W. Price exhibited specimens of Oxyurids from the large intestine of the rhinoceros Iguana (*Cyclura cornuta*) estimated to comprise 127,000 individuals.

J. R. Christie discussed briefly the head structures and phryngeal armature of oxyurids from insects.

The one hundred and first meeting of the Society was held January 15, 1927.

Dr. Steiner spoke on a new nemic family Epsilonematidae, comprising the former Rhabdogaster Metschnikoff (Epsilonema Steiner 1926) and a number of related new genera. The family is closely related to the Desmodoridae, with which it is connected through the genus Archepsilonema. The Epsilonematidae are found in all oceans and inhabit the bottom from the deeper shore waters to the deep sea. Their locomotion which is somewhat like that of the geometrid caperpillars overwhelmingly influences their morphology, line of specialization, and development. The ventral surface becomes the locomotive plane, acting as a sole. The body is separated into two distinct parts: the cephalic arc and the caudal arc, connected by a strongly and reversely bent, narrow middle part. The body thus has somewhat the shape of the Greek letter epsilon. Only the genus Archepsilonema has failed to develop this flexion but indicates its membership in this family by the presence of cylindrical, stiff ambulatory setae ventrad in the middle region of the body, a character hitherto found in all Epsilonematidae. The ventral surface of the caudal arc is commonly used as a sole. The body rests on the tail end, which has a spinneret, and on the stiff ambulatory setae, whereas the cephalic arc is bent back, held elevated, and moved around. It is exceedingly interesting to see how nature develops this form, which is apparently well adapted to the quietness of deep water. A stiff exoskeleton is naturally essential for the mode of living found in this animal group and one sees specialization and develop-

ment here producing a great variety of forms. The Epsilonematidae constitute a family including perhaps hundreds of species and a number of genera—exhibiting an almost endless variation in the construction of this exoskeleton. The exoskeletal rings are made now flexible, now stiffer and stronger; even the balloon type of modern automobile tires has had its trial as a ring type of certain Bathyepsilonemas. The mode of life also influences the body symmetry, bringing about a more pronounced bilaterality, e. g., in the dorsal shifting of the amphids. Many lines and series of specialization can be seen within the family and within the various genera; and yet up to rather recent years this whole group was barely known through a single species, *Epsilonema cygnoides* (Metschnikoff), a second one *Metepsilonema hagmeieri* being described in 1923 by Stauffer. The speaker proposed the following characters as limiting the family:

Epsilonematidae: free-living, creeping nemas, part of the ventral body surface being used as a locomotive sole, with a number of stiff, cylindrical setae ventrad on the middle region of the body, used as ambulatory setae. Cuticula annulated except at the head and tail end; which are smooth; cephalic setae mostly present but irregular; amphids spiral grooves, often shifted dorsad; pharynx narrow, seldom with denticles; esophagus cylindrical with terminal bulb, or short and consisting of two succeeding bulbs; excretory pore, where known, in head cap; double reflexed ovaries; single straight testis; two slender, strongly curved spicula, slightly capitate at proximal end; gubernaculum short, straight, linear; only marine; type genus; Epsilonema.

The genera proposed are the following:

Archepsilonema: Epsilonematidae with incompletely developed flexion in the middle region of the body separating the latter into a cephalic and caudal arc; with a cardiac bulb to the cylindrical esophagus.

Epsilonema: Epsilonematidae of which the body is well separated into a cephalic and a caudal arc connected by a narrow intermediate part, called the interflection, making the animal resemble a Greek E. Rings rather fine and numbering between 120-200, mostly around 160-190. Esophagus cylindrical with well developed cardiac bulb.

Bathyepsilonema: Epsilonematidae with the characters of Epsilonema but with rings much stronger and fewer (only 80-90).

Metepsilonema: Epsilonematidae with the character of Epsilonema but with the esophagus shortened and having two bulbs, a cardiac and a precardiac.

Dr. N. A. Cobb described a parasite of *Pachycyclops signatus* [see Journal of Parasitology, 14: p. 43.

Dr. Cobb called attention to the existence of amphids on the larva of this copepod parasite and added that thus far, during the examination of a very wide range of parasitic genera, he had in only one genus been unable to discover well developed amphids, and remarked that in the future no description of a parasitic nematode can be regarded as complete without reference to the amphids, as these are no doubt universally present, and are exceedingly important organs, probably absolutely essential to the existence of the nema.

Dr. Cobb called attention to a new species of Diplogaster from Central Africa, which, apart from being a new species, disclosed the presence, in the esophagus, of esophageal glands—presumably salivary in nature—emptying both into the pharynx near the base of the well developed dorsal onchium and into the esophagus at the base of the valve of the well developed median bulb. Apparently there are three glands located in the posterior esophageal swelling which empty at the base of the valve of the median bulb; and two in the dorsal sector of the anterior half of the esophagus, emptying one on either side of the base of the single onchium.

Dr. Cobb exhibited on microscopes specimens of a new species of nema, found parasitic in millipeds, that had been fixed with the aid of the thermolethe (exhibited at a previous meeting), the fixative being Flemming's solution used at

80° C. The osmium constituent of the Flemming's solution seemed to have acted with unusual vigor, and the probability was pointed out that this was due to the exceedingly great expedition with which the Flemming's solution was heated and the fact that the organism was shot into the fixative the very instant it reached the requisite temperature. This, and the peculiar construction of the thermolethe, resulted in the osmic acid having penetrated to the very interior of the eggs of the parasite, as was shown by the blackening of granules in the interior of the egg. The osmium had penetrated (1) the cuticula and body wall of the nema and, (2) the wall of the uterus and, (3) the shell of the egg, in order to reach these interior granules.

The thermolethe will be described, with illustrations, in the Transactions of the American Microscopical Society.

Dr. W. W. Cort noted that in connection with studies carried on in Panama last summer on hookworm disease, some examinations were made of groups of people, who had been very little influenced by control measures. It was found that pollution of the soil near the houses was the chief method of dissemination. In certain areas environmental conditions appeared to be unusually favorable, since there was an abundance of vegetation near the houses, a favorable type of soil and a long rainy season, almost eight months in length. Under these conditions uncontrolled soil pollution had built up the group infestations beyond any previously recorded by quantitative methods. In certain of the groups the anemia produced was not in proportion to the worm burden, and the people were apparently injured to a much less extent than was expected by their heavy infestations. In fact the group with the highest average infestation had an average hemoglobin per cent only a little lowered. This group was a mixture of Indians and Negroes, and being very well off economically for the country, was well nourished. Another group of lower average infestation, who were much poorer and with a much larger percentage of white blood, had a much reduced hemoglobin average. Apparently the factors of race and nutrition are important in Panama in determining the effects of hookworm infestation on the people.

C. W. Stiles and Clara Edith Baker presented the following: In connection with recent work on the various species of the nematode genus *Gongylonema,* the question has naturally arisen whether the species reported for man have any significance in the causation of cancer similar to conditions reported for *Gongylonema neoplasticum,* in the stomach of rats, and also whether *G. scutatum* (of cattle) is identical with *G. pulchrum* (of swine), with which, according to some authors, the gongylonemas of man are identical.

G. scutatum is exceedingly common in cattle in the United States, but no cases seem to be reported of its concurrence with cancerous growth.

Baylis, Pan, and Sambon (1925) have anticipated us in reporting the experimental transmission of *G. scutatum* of cattle to rats. This species has also been experimentally transmitted to sheep (Ransom and Hall, 1915) and to swine (Baylis, Sheather and Andrew, 1926).

In 1925, experiments were instituted, in the Hygienic Laboratory, to transmit experimentally *G. scutatum* of cattle to white rats (*Rattus norvegicus albus*) using the croton bug (*Blattella germanica*) as intermediate host.

Briefly summarized, six of these experiments were negative, two were positive. The positives were very light infections (one worm in each rat). In one rat a male worm was found (5 months after infection), in the other case a female worm developed (6 months after infection). In each positive the gongylonema was located in the esophagus, while the stomach was normal without any indication of cancer.

Conclusions: Observations on many cases of *G. scutatum* in cattle slaughtered at Washington, D. C., and the findings in these two cases of experimental infections of *G. scutatum* in white rats do not give evidence that this gongylonema has any etiological relation to cancer such as is reported for *G. neoplasticum* of rats.

The one hundred and second meeting of the society was held February 19, 1927.

Drs. N. A. Cobb and G. Steiner called attention to the need for a more intensive study of certain Aphelenchi. The frequent finding of *Aphelenchus subtenuis* Cobb 1926 in diseased narcissus bulbs and the recent discovery of what seems to be *Aphelenchus ritzema-bosi* in zinnias raises the question of the status of various forms hitherto described as specifically different. Differences in the published descriptions may have resulted from oversight. Some observers stress the differences in size of forms taken from various host plants, but possibly these differences are simply of phenotypical character; no experimental proof to the contrary exists. Authors seem to cite as a specific characteristic of *A. ritzema-bosi* the production of brown spots on chrysanthemums, and of *A. fragariae* the appearance of "bunch" or "cauliflower" in strawberry plants. Such statements are open to exception until it is shown experimentally that these symptoms are not simply varying reactions of different plants to the same cause.

A weak character used to distinguish the various forms is the location of the excretory pore, which obviously often varies in its relative position to the esophageal bulb because of the latter's mobility. A useful and more decisive character is the number and position of the papillae of the male tail end. Yet some of the more inconspicuous of these papillae may easily be overlooked; if overlooked, failure to record them is no proof that they were not there. Thus the investigator of today must continually wonder whether they were not overlooked by earlier workers. Assuming the published descriptions to be complete and accurate, succeeding observers may propose new species, perhaps only because they have the advantage of better instruments and of accumulated experience.

What is needed is a careful reexamination and comparison of Aphelenchi from various host plants and experiments on the reaction of these plants to the same form. Such researches may prove *A. fragariae* Ritzema-Bos, *A. olesistus* Ritzema-Bos, *A. ritzema-bosi* Schwartz, and *A. subtenuis* Cobb to be but a single species. If so, it is important to know it.

Doctor B. Schwartz discussed the species of Dipylidium parasitic in dogs and cats in the United States. Most specimens from the United States and Asia examined by him had from 5 to 7 rows of hooks on the rostellum. On a critical consideration of Millzner's recent study of Dipylidium he is unable to concur in her conclusions as regards the presence of seven species of this genus in dogs and cats in the United States.

Millzner's five new species, namely, *D. crassum, D. compactum, D. gracile, D. longulum* and *D. diffusum* are based on such variable characters that it seems impossible to accept these species as valid. Millzner differentiates her new species from each other and from *D. sexcoronatum* on the basis of the size and shape of the neck, compactness of the ovary, diameter of the head, number of testes in the mature proglottids, and on similar characters known to vary widely with varying states of contractions or technic or otherwise. Specimens of Dipylidium show marked activity in vitro and contract and relax alternately, thus lengthening and shortening not only the neck but also the remaining portion of the strobila. If specimens are killed while they are contracted the neck will be short and broad, whereas if they are killed while they are in a state of muscular relaxation the neck will usually appear long and slender. Adjoining segments in a strobila may show marked differences in the compactness of the ovary and vitellarium, some segments showing the follicles as a compact mass and other segments showing more or less discrete follicles. An ovary which stains diffusely is not necessarily a "diffuse" ovary, but is in all probability the result of some feature in technic such as poor fixation, the use of a non-differential stain, insufficient or excessive destaining, or of some other factor in technical manipulation.

Aside from such things as contraction and technic, the width of the head of cestodes is variable within comparatively wide limits and this is also true with

regard to the number of testes present in a mature proglottid. Millzner's synoptic key to her new species is based on the diameter of the head, the number of testes, the size and shape of the neck and diffuseness or compactness of the ovary, and the contrasting and differential characters given in her key are within the limits of variation of a single species. Attempts to determine specimens of Dipylidium with that key were unsuccessful. Specimens of the genus from dogs did not fit the key at all in some cases, and other specimens examined could be placed in any one of her five new species, as well as in *D. sexcoronatum.*

D. walkeri of Sondhi is another species which has not been sufficiently differentiated from *D. sexcoronatum* to warrant the erection of a new species. Dr. Schwartz believes that no sound evidence has as yet been presented which proves that more than two species of Dipylidium, namely, *D. caninum* and *D. sexcoronatum,* occur in dogs and cats in the United States.

In discussion, Dr. E. L. Taylor noted that some work he had done on the species of the genus *Moniezia* might strengthen Dr. Schwartz's argument. He had attempted to ascertain how many of the described species were valid, which of the characters were good, and which were nothing more than individual variation. He had prepared and examined some thirty entire worms, from head to terminal segment, and a most striking variation, in what had been cited as specific characters, was noted; it was found that some individual worms could be divided into four or five parts to fit in with four or five specific descriptions.

Dr. Taylor mentioned as a striking example of variation, the species *M. trigonophora,* which had been based on the arrangement of the testes into two triangular groups, as opposed to the band of testes stretching across the segment as seen in other species. In some individuals all the segments in which the testes could be seen showed this character, while in other individuals this character was entirely absent; but a number of intermediate forms were found, in which the percentages of testiculate segments showing the triangular arrangement of testes formed the following series: 0.5, 2, 4, 5, 8, 10, 22, 39, 60, 81, and 82 per cent. The presence of these intermediate forms makes it quite clear, apparently that this arrangement of the testes is not a good specific character, but is merely an individual variation. Among the more striking individual variations of size, he had found the scolex to vary in diameter from 0.6 mm. to 1.75 mm. and the length of the neck to vary from 0.75 mm. to 2.25 mm. The interproglottidal glands varied greatly in both size and number, in some individuals there were series of segments without any of these glands, while there were many segments in the same worm with as many as eighteen glands; in other individuals the number of glands varied between 40 and 70. The size and shape of mature segments varied from those 8 mm. broad and 0.8 mm. long to those in other worms in which the length of the segment was actually a little greater than the breadth. All these extremes were connected together by gradual steps, and in the particular characters mentioned he could find no grouping into species.

In his opinion it was not sufficient to examine a few segments from the strobila, and from those few to define the limits of variation for the species, since, as had been shown in his observations, such a method may even fail to limit the range of variation in one individual.

Dr. H. E. Ewing pointed out the need of indicating, in the titles of articles containing the descriptions of new species, the orders or families to which these new species belong. This would be especially helpful to such publications as Biological Abstracts in the assigning of articles to specialists for abstracting.

J. R. Christie noted that until recently little has been known regarding the occurrence of males in the genus Mermis. Hagmier, the only investigator reporting the occurrence of males i nthis genus, found two individuals which he regarded as *Mermis nigrescens,* Dujardin, 1842. During the past summer (1926) an attempt was made at Woods Hole, Mass., to secure post parasitic forms of

M. subnigrescens Cobb, 1926, by digging in a location where, during the previous season, the grasshoppers were heavily infested. Out of a total of 27 individuals secured in this manner, 2 were males.

Between August 8 and 12, 1926, there were collected, in localities where the infestation with *M. subnigrescens* was known to be high, several hundred grasshoppers. These were placed in a cage containing three inches of moist soil on which wheat had been previously sown. On August 16, the soil in the cage was examined and 62 mermithids were recovered, 33 of which were females and 29 males. At the time of emergence the developing spicula of the males can usually be detected with low magnification, making a determination of sex comparatively easy.

In spite of these facts which indicate that males of *M. subnigrescens* are by no means rare, females bred from grasshoppers and reared in the absence of males, produce eggs containing active, infective embryos.

Mr. Christie also commented briefly on the retarding effect of *Mermis subnigrescens* on the development of grasshoppers and exhibited specimens of infested and noninfested nymphs of the same age.

Dr. E. B. Cram presented the following: Recent identification of the following nematodes appears to establish new records of distribution. From Managua, Nicaragua, *Subulura differens* from the chicken (*Gallus gallus*); collected by P. Solorzana. This nematode has been previously reported from Brazil but this is the first Central American finding and it has not yet been found in North America. From Mayaguez, Porto Rico, from the chicken (*Gallus gallus*), *Cheiospirura hamulosa* and *Capillaria annulata;* from the guinea hen (*Numida meleagris*), *Ascaridia numidae* and *Heterakis brevispiculum,* both these species having been reported originally from Africa, and the latter species subsequently from Brazil, and *Dispharynx spiralis,* which is known to occur in the United States and is fairly cosmopolitan; from both *Gallus gallus* and *Numida meleagris, Subulura strongylina,* this being the first record of this species from the latter host and the first record of the nematode outside of Brazil; from the cat (*Felis domestica*), *Diphyllobothrium mansoni.* These Porto Rican specimens were all collected by Dr. G. Dikmans. From China, from the chicken (*Gallus gallus*), *Davainea tetragona* and *Davainea echinobothrida;* from the duck (*Anas platyrhyncha*) and the goose (*Anser anser*), *Hymenolepis collaris,* which had been found formerly in that part of the world in Australia and (probably this species) according to Southwell, in *Anas poecilorhyncha* in India.

Dr. E. L. Taylor reported the finding of *Muspicea borreli* Sambon 1925 in the connective tissue surrounding the inguinal lymphatic gland of a white mouse from the experiment station at Bethesda, Md.

One hundred and ninety sluggish larvae were counted in a crush preparation of the gland, and unfortunately the only mature worm present, a female, was badly broken and it was not possible to add anything to Sambon's description which might help to place this nematode in its proper group.

Dr. Taylor said that the specimens from which Sambon made his descriptions were found by Borrel at Strasburg in mice used in the extensive cancer research there, and so far as he knew no report of the occurrence of this parasite had been made since that time.

The hundred and third meeting of the Society was held March 19, 1927.

Dr. Stiles referred to a circular on nomenclature based on the resolution taken by the American Society of Parasitologists against the propositions made by Dr. Poche of Vienna, Austria. By a unanimous vote the Helminthological Society endorsed the resolution.

Dr. L. H. Prince read a paper on *Endamoeba coli* and *Councilmania lafleuri* showing the two to be identical and proposed that Councilmania become a synonym of Endamoeba. Dr. Prince exhibited a series of lantern slides.

Dr. E. L. Taylor presented the following:—In 1924 I reported the finding of Toxascaris in the cat in Great Britain, and endeavored to show that worms of this genus occurring in the dog, cat and lion are morphologically identical, and should all be included in the species *Toxascaris leonina* (Linstow 1902).

Dr. Hall has recently called my attention to a paper by L. G. Seurat and H. Neuville in which the authors figure the eggs of *Toxascaris leonina* as containing fully mature embryos, and state in the text that in the uterus of this species eggs may be found in every stage of segmentation. The specimens in which these observations were made had been collected from the small intestine of a lion and immediately placed in 10 per cent commercial formalin, where they remained until examined five months later, when some of the eggs in the uteri of the worms were found to contain mature and living embryos.

From these observations the authors of the paper conclude that embryos of this species do not develop excepting at the body temperature of the host, and that embryos already matured are not killed in a solution of 10% formalin after a lapse of five months time. That these conclusions may be wrongly drawn is readily suggested, and one asks whether it is not more likely that some of the eggs were infertile from the beginning, some embryos were killed by the strong solution of formalin, while other more vigorous ones, protected perhaps by a thicker shell, were able to develop to maturity during the five months time which elapsed between the autopsy of the lion and the examination of the worms?

In order to clear this point I examined some Toxascaris in the collection of the Bureau of Animal Industry. In the first bottle, the specimens (collected from the lion) were seen to contain mature embryos in a small proportion of the eggs. I then came across a bottle of specimens from the lion, labeled "killed in hot alcohol," but although eggs from the uteri of three female worms were carefully examined none were found in any but the earliest stage of segmentation. Following this an examination of eggs from the uterus of specimens collected from the dog was made, and fully developed embryos were readily found.

It therefore appears evident that the eggs of *Toxascaris* from the lion do not differ from those of the *Toxascaris* of the dog in containing mature embryos; but that in either host, eggs in the uterus of freshly collected specimens are to be found in the same early stage of segmentation.—References:—Seurat, L. G., and Neuville, H., 1913. Sur le *Toxascaris leonina* (Linstow) Bull. Mus. d'hist. nat. No. 1.—Taylor, E. L., on the ascarids of the dog and cat, Ann. Trop. Med. & Parasit., vol. 18, no. 3.

Dr. N. A. Cobb presented three notes entitled as follows:

1. *Tylenchus penetrans* Cobb. This name is probably a synonym of *Tylenchus pratensis* de Man. Cobb has found this nema to infest fig roots in California (Feb., 1927).

2. Nemic Sperms of New Form. The sperms of a common nemic parasite of the smaller house cockroach (*Blatella germanica* L.)—the nemic species *Blatticola blatticola* (Galeb 1878) Schwenck 1926—present the form of a wishbone of the common domestic fowl, having faintly arcuate clavicular bones very near together, rather like the prongs of a clothes-peg, and the hypoclidium very long, slender and straight—even longer than the two symmetrical branches.

3. *Aphelenchus parietinus* Bastian. Cobb finds this species to be sometimes a rather common parasite of Narcissus bulbs in the extreme northwestern part of the United States. The sperms of this species, or their parent cells, seem to be transferred to the female in definite batches, sixteen being often seen grouped in the single postvalvular spermatheca of the female as spherical elements, sometimes arranged in pairs, as if still dividing. The sperms in the uterus are of a different form and structure and are arranged in single file, roughly speaking in the form of a roll-of-coin.

Dr. G. Steiner exhibited a slide with roots of the lily-of-the-valley infested with *Tylenchus pratensis* de Man. The roots were treated by a method inaugurated

by E. G. Arzberger of the Bureau of Plant Industry in his studies of mycorrhizal organisms. By this method the roots are fixed for 12 hours in a medium Flemming's solution and then washed for 12 hours in running water. Nemas in soft roots, which are not yet much lignified, are thus made plainly visible. The nemas are more blackened than the root tissue and can even be identified in the roots in many cases. If the roots are too black to be transparent enough, they can be treated with various clearing fluids. Of course, with lignified roots, this method does not work, but with fine "soft" roots it leads most often to quick and excellent results and shows the nemas in their natural position within the root tissues. A few remarks were also made about the significance of *Tylenchus pratensis* de Man as a plant parasite and its synonyms *Tylenchus penetrans* Cobb and *Aphelenchus neglectus* Rensch. This nema does not produce any specific pathological symptoms and yet may be one of the worst plant parasitic forms, widely spread and attacking an extensive range of hosts, but unfortunately often overlooked because of its entirely endoparasitic life.

Dr. J. E. Shillinger presented the following note:—In view of the active campaign carried out in certain sources promoting the sale of santonin as an anthelmintic and the extravagant claims made for its efficacy as set forth in advertisements as well as in articles in medical, veterinary and pharmacological journals it was decided to make critical tests of the product. A sample of the pure drug was procured and was used in varying sized doses, alone and in combination with purgatives, in different species of domestic animals. It was administered to them in their rations to a group and as individual treatments, after having recently been fed and after variable periods of fasting. Every effort was made to determine if the drug possesses the high degree of efficiency sometimes claimed for it. Post-mortem examination was made of all the test animals used and the remaining worms counted. The highest degree of efficacy was obtained by individual treatment of the test animals with doses several times the usually prescribed amounts followed some hours later with a purgative. In most cases it was considerably less than fifty per cent effective. In no instance was a degree of efficacy obtained from single doses of santonin, with or without a purgative, that would justify the opinion that santonin is a practical treatment for the removal of worms from livestock.

Mr. H. W. Brown presented a note on The Relation of Ascaris to Pot-Belly.—Of 30 children of a rural community in Panama with very definite pot-bellies only about one half of them were found to be harboring Ascaris, indicating that enlarged abdomens of children of this region are not to be of critical diagnostic value for this parasite. Several children harboring large numbers of Ascarids were without any abdominal distension. One child harboring about 400 worms of a total length of 300 feet and total volume of 1,000 cc. had a normal appearing abdomen. One child with a large pot-belly and a large number of Ascarids had no decrease in the size of her abdomen within six months after the removal of her worms.

J. R. Christie, *Secretary.*

BOOK REVIEWS

Gifttier und Ihre Giftigkeit. By Dr. E. N. Pawlowsky. Gustav Fisher, Jena, 516 pp., 176 textfigures.

In a single volume the author, who is Professor of Zoology and Comparative Anatomy in the Academy of Military Medicine at Leningrad, has brought together an immense amount of valuable material and has presented it with great clearness and admirable completeness. The work starts with a consideration of those protozoa which possess poisonous organellae. It then discusses the nettling cells of Coelenterata and the poison spines and pedicellariae of Echinodermata. Other groups are taken up in the same fashion. The source and production of the poison as well as means by which it is transferred are considered in each case. The effect upon the human organism and such problems as individual immunity are also treated. Even such toxic phenomena as have their origin in parasitism of various species has received careful consideration. The work is beautifully printed and will take its place at once among the indispensable works of reference in the hands of all who are working in medical zoology or are interested in the relations of man to other animals.

Les Néoplasmes et leur therapeutique medicale. Ed. Baronaki. Norbert Maloine, Paris, 140 pp.

In the present day when there is so much discussion concerning the relation of parasites to cancer, this little book will be useful. It presents in brief form a discussion of the subject in a way to give the reader a clear conception of the views of the author. He is not inclined to accept the view of the parasitic origin of cancer.

Part I of the *Report of the Director of Veterinary Education and Research for the Union of South Africa* is an impressive publication of 820 pages with many figures. It covers a wide range of subjects among which many items are of importance to parasitologists.

In his very interesting and valuable book on *The Beaver* (Williams & Wilkins Co., Baltimore, 1927) Edward R. Warren has a brief section on the unique beetle, *Platypsyllus castoris,* which is an ectoparasite of this host, and on *Leptinillus validus,* an associate parasite. No mention is made of the endoparasites of the beaver.

Tropical Diseases Bulletin for May, 1927, has introduced an interesting innovation in the form of a "Historical" section dealing with early records of research and discoveries in the domain of tropical medicine. The subjects dealt with include early Portuguese contributions to tropical medicine, and past records of plague, malaria, dysentery, leprosy and scurvy.

The *Journal of the Burma Research Society* now devotes one of its three yearly numbers to scientific articles. These numbers for 1925 and 1926 contain important contributions on the parasitic fauna of Burma.

NOTES

The Helminthological Society of Washington announced in the Journal (12: 224, June, 1926) the establishment of a memorial to Dr. B. H. Ransom. The committee has come to the decision that the fund be invested and that the interest be used as a money prize of $100 when that amount is available, to be awarded by the committee to a person of any nationality who has not passed his 40th birthday at the time of the award, and who has made a comparatively recent noteworthy contribution in the field of human or veterinary parasitology. The fund at present totals $825, subscribed by approximately 100 persons, the individual subscriptions ranging from $1 to $25. Further subscriptions will be welcome from any who are interested to participate.

An International Congress of Hygiene will be held at the Pasteur Institute at Paris, October 25-28, 1927, in connection with the Semi-Centennial of the *Société de Médecine Publique*. The technical program and also the exposition which is strictly technical will be held at the Pasteur Institute. The Congress is under the patronage of the President of the French Republic and the honorary presidents are Dr. Roux, Director of the Pasteur Institute, and Professor Roger, Dean of the Faculty of Medicine.